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Canopy™ 45 Mbps Backhaul

User Guide

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CANOPY™
Motorola Wireless Broadband Platform

Compliance

General

Intentional or unintentional changes or modifications to the equipment must not be made unless under the express consent of the party responsible for compliance. Any such modifications could void the user's authority to operate the equipment and will void the manufacturer's warranty.

NOTE: This system has achieved Type Approval in various countries around the world. This means that the system has been tested against various local technical regulations and found to comply. The frequency band in which the system operates is 'unlicensed' and the system is allowed to be used provided it does not cause interference. Further, it is not guaranteed protection against interference from other products and installations.

The system has basically been shown to comply with the limits for emitted spurious radiation for a Class B digital device, pursuant to Part 15 of the FCC Rules, as well as comparable regulations in other countries. (A Class B Digital Device is a digital device that is marketed for use in a residential environment, notwithstanding use in commercial, business and industrial environments.) These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the Outdoor Unit (ODU).
- Increase the separation between the equipment and ODU.
- Connect the equipment into a power outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for help.

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Contents

1 Getting Started 6
1.1 For Your Safety 6
1.2 Welcome 6
1.3 Product Description 7
1.4 License, Warranty, and Trademark Information 11
2 Product Architecture 15
General Considerations 16
3.1 Frequency Planning 16
3.2 Distance 16
3.3 Networking Information 16
3.4 Lightning Protection 16
3.5 Electrical Requirements 16
4 Site Planning 17
4.1 Site Selection Criteria 17
4.2 Collocating Backhauls 19
5 Installation 21
5.1 Preparation 21
5.2 Installation Procedure 21
5.3 Tools Required 21
5.4 Installation Support 21
5.5 Legal Disclaimer 22
5.6 Mounting the ODUs 22
5.7 Connecting Up 23
6 Web Page Reference 30
6.1 Home Page 30
6.2 Systems Status Page 32
6.3 System Administration Pages 37
7 Fault Finding 76
7.1 Hardware 76
7.2 Radio 79
8 Specifications 80
8.1 System Specifications 80
8.2 Safety Compliance 84
8.3 EMC Emissions Compliance 84
8.4 EMC Immunity Compliance 85
8.5 Radio Certifications 85
8.6 Environmental Specifications 85
8.7 System Connections 87
9 Lightning Protection 88
9.1 Overview 88
9.2 Detailed Installation 88
10 Wind Loading 92
10.1 General 92
10.2 Calculation of Lateral Force 92
10.3 45 Mbps Backhaul Capabilities 93
10.4 Wind Speed Statistics 93
11 Connectorized 45 Mbps Backhaul 94
11.1 Scope 94
11.2 Product Description 94
11.3 Software/Features 94
11.4 Deployment Considerations 99
11.5 Link Budget 99
11.6 Regulatory Issues 100
Antennas for USA / Canada 101
11.8 Installation 102
12 FAQs 106
13 Glossary 108
14 Index 109

List of Figures

Figure 1 45 Mbps Backhaul Outdoor Unit (ODU) 8
Figure 2 45 Mbps Backhaul Power Indoor Unit (PIDU) 9
Figure 3 45 Mbps Backhaul Reset Switch Location 9
Figure 4 45 Mbps Backhaul PIDU Power Input 10
Figure 5 45 Mbps Backhaul Layer Diagram 15
Figure 6 Completed ODU connector 24
Figure 7 RJ45 Pin Connection 24
Figure 8 Disconnecting the ODU 26
Figure 9 45 Mbps Backhaul Home Page 30
Figure 10: Alarm Warning Triangle 31
Figure 11 Status Page 32
Figure 12 System Administration Login Page 37
Figure 13 Configuration Page 38
Figure 14 Configuration Reboot Page 40
Figure 15 Statistics 41
Figure 16 License Key Data Entry 44
Figure 17 Installation Wizard Internet Protocol Configuration 45
Figure 18 Installation Wizard Wireless Configuration 46
Figure 19: Fixed Frequency Operation 48
Figure 20 Installation Wizard Confirm Configuration. 49
Figure 21 Disarm Installation. 50
Figure 22: Optional Post Disarm Configuration 51
Figure 23 Software Upgrade 52
Figure 24 Software Upgrade Image Check 53
Figure 25 Software Upgrade Complete 54
Figure 26 DFS as seen from the Master 57
Figure 27 Spectrum Management as seen from the Slave 58
Figure 28 Example Spectrum Management Graphic 59
Figure 29: Active Channel History Screen 60
Figure 30 Spectrum Management Timeseries Plot 61
Figure 31 SPECTRUM MANAGEMENT Help Page 62
Figure 32: Spectrum Management Fixed Frequency Screen 63
Figure 33: UK DFS Master Screen 65
Figure 34: UK DFS Slave Screen 66

Figure 35 Remote Management 67
Figure 36: Diagnostics Download 71
Figure 37 Password Change 72
Figure 38: Software License Key Data Entry 73
Figure 39: License Key Reboot Screen 74
Figure 40: Properties 74
Figure 41 System Reboot 75
Figure 42 Main System Connections 76
Figure 43 ODU to PIDU Connection Diagram 87
Figure 44 ODU Mounted in Zone B & ODU Mounted in Zone A 89
Figure 45 ODU mounted inside Zone B 89
Figure 46 Diagram showing a typical installation 90
Figure 47 Upper Configuration and Lower Configuration 91
Figure 48 Connectorized 45 Mbps Backhaul Outdoor Unit 94
Figure 49 Connectorized 45 Mbps Backhaul Status Page 95
Figure 50 Connectorized 45 Mbps Backhaul 'System Configuration' Page 96
Figure 51 Connectorized 45 Mbps Backhaul 'Installation Wizard' Page 97
Figure 52 Connectorized 45 Mbps Backhaul 'Confirm Installation' Page 98
Figure 53 Connectorized 45 Mbps Backhaul 'Disarm Installation' Page 98
Figure 54 - Forming a Drip Loop 105
Figure 55 - Weatherproofing the Antenna Connections 105

List of Tables

Table 1 Reset Actions 10
Table 2 Aggregate Ethernet throughput rate v maximum link loss 19
Table 3 Audio indications from the ODU 28
Table 4 45 Mbps Backhaul Factory Configuration Values 43
Table 5 Spectrum Management (Non UK) change state key 60
Table 6 DFS timeseries key 61
Table 7 DFS change state key 66
Table 8 Protection Requirements 90
Table 9 Static Link Budget for Various Antenna Options 99
Table 10 Cable Losses per Length 100
Table 11 Allowed Antennas for Deployment in USA/Canada 101

List of Equations

Equation 1 Path Loss 18
Equation 2 Link Loss 35

1 Getting Started

1.1 For Your Safety

Caution! Users and installers should note: To disconnect power from the Canopy 45 Mbps Backhaul, unplug the unit from AC (mains). There is no power switch on the unit.

Warning! Use extreme care when installing antennas near power lines.

Warning! Use extreme care when working at heights.

Caution! When the system is operational, avoid standing directly in front of the antenna. Strong RF fields are present when the transmitter is on. The Outdoor Unit (ODU) must not be deployed in a location where it is possible for people to stand or walk inadvertently in front of the antenna.

Warning! A 45 Mbps Backhaul Outdoor Unit must be properly grounded to protect against lightning. It is the user's responsibility to install the equipment in accordance with Section 810 of the National Electric Code, ANSI/NFPA No.70-1984 or Section 54 of the Canadian Electrical Code. These codes describe correct installation procedures for grounding the outdoor unit, mast, lead-in wire and discharge unit, size of grounding conductors and connection requirements for grounding electrodes. Installation of the outdoor unit should be done by a professional installer familiar with codes and safety practices.

Caution! Safety will be compromised if external quality cables are not used for connections that will be exposed to the weather.

Caution! Safety will be compromised if a different power supply is used than the one supplied by Motorola as part of the system.

1.2 Welcome

Congratulations on your purchase of a 45 Mbps Backhaul system from Motorola.

1.2.1 About This Guide

This guide covers the installation, commissioning, operation and fault finding of the 45 Mbps Backhaul system.

1.2.2 Who Should Use This Guide

The guide is for use by the system installer and the end user IT professional.
The system installer will require expertise in the following areas:

- Outdoor radio equipment installation
- Network configuration
- Use of web browser for system configuration, monitoring and fault finding

1.2.3 Feedback on Documentation

We welcome your feedback on Canopy documentation. Comments on structure, content, accuracy, completeness, or any other area are appreciated. Please send your feedback to technical-documentation@canopywireless.com.

1.2.4 Technical Support

If problems arise, the Canopy support team is here to help. Here is the escalation path for resolution of a problem:

- Check this document.
- Escalate the problem to your Canopy supplier.
- Escalate the problem to Canopy Technical Support or other designated Tier 3 technical support:

Canopy Technical Support

email: technical-support@canopywireless.com

1 888 605 2552

or

+1 217 824 9742

When you send e-mail or call, please include the following information:

- Information on your network configuration, especially IP addresses and MAC addresses.
- Version numbers of the software on the modules with problems.

1.2.5 Repair and Service

For warranty assistance or repair, contact your reseller or distributor for the process.

1.3 Product Description

This User Manual is specifically written for the Canopy 45 Mbps Backhaul and the 5830 software load.

The 45 Mbps Backhaul has been developed to provide Point-to-Point data connectivity via a 5.8 GHz wireless Ethernet bridge operating at broadband data rates. It provides either high bandwidth connectivity where more throughput is needed than provided by the Canopy 20 Mbps Backhaul, or non-Line-of-Sight operation.

The 45 Mbps Backhaul offers true non-Line-Of-Sight (NLOS) operation by using a combination of Orthogonal Frequency Division Multiplex (OFDM) modulation and Multi-Beam Space Time Coding (STC) techniques. These technologies enable the 45 Mbps Backhaul to drive through foliage and around buildings to such an extent that almost universal coverage can be expected at short range.

The 45 Mbps Backhaul consists of a pair of identical devices that are deployed one at each end of the link. At install time the user sets up one unit as the Master and the other as the Slave. Either unit can be configured as master or slave.

Each end of the link consists of:

- An integrated outdoor transceiver unit containing all the radio and networking electronics hereafter referred to as the Outdoor Unit (ODU).
- An indoor connection box containing status indicators and network connection. Hereafter referred to as the Power Indoor Unit (PIDU).
- Units will normally be supplied pre-configured as a link.

Power is fed into the PIDU from the mains power adaptor via a standard IEC AC (mains) plug. The network connection is presented to the user at the PIDU via an RJ45 socket. Connection between the ODU and PIDU is made using standard CAT 5 UV resistant cable. The spare twisted pairs of the cable are used to feed power from the PIDU to the ODU.

1.3.1 The Outdoor Unit (ODU)

The ODU (Figure 1) is a self-contained unit. It houses both radio and networking electronics. A single CAT 5 cable feeds the unit. Power is fed to the unit from the Power Indoor Unit (PIDU) (Figure 2) via the brown/brown white pair connected to pins 7 and 8 of the RJ45 plugs and sockets. It should be noted that this is a different convention for Power Over Ethernet (POE) than used with some other equipment, in particular the other Canopy Backhauls and Canopy Access Points. The 45 Mbps Backhaul ODU should only be deployed using the supplied 45 Mbps Backhaul PIDU.

Important! The Canopy Cluster Management Module 2 CMM2) and Cluster Management Module micro (CMMmicro) often used to power Canopy 20 Mb and 10 Mb Backhauls and Access Points uses a different convention (different pins) for Power Over Ethernet than does the 45 Mbps Backhaul. **Do not connect the ODU directly to a CMM2 or CMMmicro.** While the lower voltage of the CMM2 or CMMmicro may not damage the ODU, the arrangement will not work to power the ODU.

The 45 Mbps Backhaul can be connected to the Ethernet switch in the CMM2 or the CMMmicro, but through the PIDU first. Connect the ODU to the PIDU using (powered) Ethernet cable, then connect the PIDU to the CMM using Ethernet cable. For the CMM2, plug the cable into the Uplink Port. For the CMMmicro, plug the cable into any **unpowered** port.

Figure 1 45 Mbps Backhaul Outdoor Unit (ODU)

1.3.2 The Power Indoor Unit (PIDU)

The 45 Mbps Backhaul PIDU is used to generate the ODU supply voltage from building AC (mains). The PIDU also houses status indicators driven from the ODU over the blue & blue/white pair connected to pins 4 and 5 of the RJ45 plugs and sockets employed.

Figure 2 45 Mbps Backhaul Power Indoor Unit (PIDU)

The front panel contains indicators showing the status of the power and Ethernet connections.

The power indicator is illuminated when the PIDU is receiving AC (mains) power.

The Ethernet indicator normally illuminates when the Ethernet link is working; Flashing when there is Ethernet activity; the fact that it lights also indicates that the ODU is powered. At power up the LED will flash 10 times to indicate that a correct start up sequence has occurred. See Section 7 for further fault finding information.

The bottom of the PIDU houses the Ethernet connection via RJ-45 socket, an entry point for PIDU/ODU cabling and the reset button.

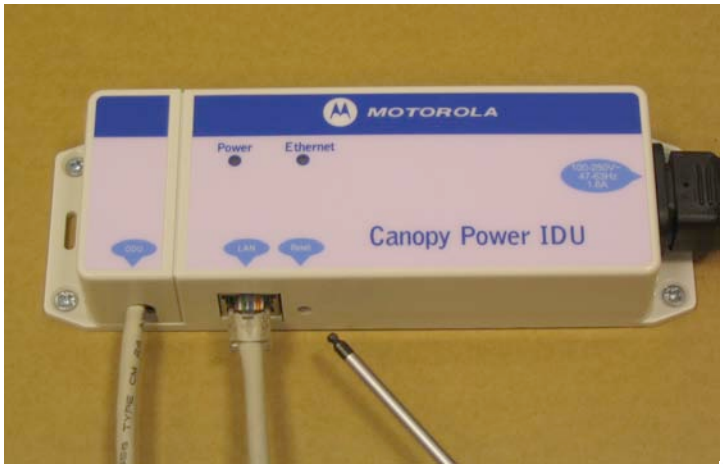

Figure 3 45 Mbps Backhaul Reset Switch Location

The reset switch is used for various purposes identified in Table 1.

Reset Button Depression	Action
More than 20 seconds, while the unit is already powered up.	This resets the configuration to factory defaults.
While connecting power for more than 40 seconds after power is applied	This resets to factory defaults and erases any user loaded software images leaving the factory loaded image intact.
None	Power cycle by switching off at the AC receptacle (mains). All settings remain the same.

Table 1 Reset Actions

1.3.3 PIDU AC Power

The PIDU converts AC (mains) input to the Power Over Ethernet (POE) output by the ODU. The input supply range for the PIDU is 90V-264V AC, 47-63Hz.

Figure 4 45 Mbps Backhaul PIDU Power Input

1.3.4 Cables and Connectors

The cable used to connect the PIDU to the ODU can be any standard CAT 5 type provided that it is suitable for outdoor deployment. Motorola recommends that cables to the specification below be used.

NEC/CEC: CMR (ETL) C (ETL) 75C SUN RES OIL RES II

Failure to use the recommended (or equivalent) standard of cable may invalidate the system's safety certification.

Since the connection from the PIDU to the ODU is part of network infrastructure and is often operating in a high RF environment due to nearby equipment and the potential for lighting-induced currents, the use of shielded cables is strongly recommended.

The connection between the PIDU and user's equipment can be made using any standard CAT5 patch cable. The RJ45 Ethernet connection is presented as a piece of network equipment. However as automatic MDI/MDI-X sensing and pair swapping is employed a crossed or no crossed Ethernet patch cable can be used for connection to another piece of networking equipment or directly to end user equipment.

The PIDU provides continuity between the shield on the ODU-PIDU cable and the shield on the PIDU-User equipment cable. If continuity of the shielding is desired from the ODU-PIDU to the user's equipment, CAT 5 STP cable and connectors should be used for the latter connection. CAT5 STP cable between the PIDU and the user's equipment will provide additional protection against surges induced on the Ethernet connections.

1.3.5 Surge Arrestor

The PIDU does not provide lightning or surge suppression. Lightning and surge suppression should be provided by a separate Ethernet surge suppressor appropriately grounded. Suitable surge suppressors can be sourced from your Motorola distributor or reseller. The ODU is protected by built-in surge suppression as standard. See 9 "Lightning Protection".

1.3.6 Mounting Brackets

The 45 Mbps Backhaul is supplied with a mounting bracket suitable for mounting the ODU to a pole of 50mm to 75mm in diameter or to a flat surface. For more details on mounting, see section 5 "Installation".

The bracket allows for adjustment in both azimuth and elevation. The bracket may be mounted to the pole or wall prior to installation. This allows the installer to take the weight of the unit on a single mounting bolt while fitting the retaining nut and washers.

The PIDU can either be desk or wall mounted. The preference is wall mounted with the cables dressed to a cable channel. Wall mounting is achieved by screwing through the mounting lugs on either side of the unit. Remember to leave space for access to the reset button. See section 5.7.7.

1.3.7 Configuration and Management

Configuration and Management of the 45 Mbps Backhaul is implemented using an inbuilt web server hosting a number of Configuration and Management web pages. This approach allows Configuration and Management to be carried out on any standard web browsing technology. The 45 Mbps Backhaul can also be managed remotely using the SNMP management protocol. Connection to the 45 Mbps Backhaul is via the Ethernet connection carrying the bridge network traffic. Connection to the unit is via a preset IP address. This address can be changed via the Network Interface Configuration web page. A full explanation of the available web pages and their use can be found in section 6 "Web Page Reference".

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Motorola U.S. offers a warranty covering a period of 1 year from the date of purchase by the customer. If a product is found defective during the warranty period, Motorola will repair or replace the product with the same or a similar model, which may be a reconditioned unit, without charge for parts or labor.

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2 Product Architecture

The 45 Mbps Backhaul consists of an identical pair of units deployed one at each end of the link. The radio link operates on a single frequency channel in each direction using Time Division Duplex (TDD). One unit is deployed as a master and the other as a slave. The master unit takes responsibility for controlling the link in both directions.

The non-Line-of-Sight (NLOS) aspects of the product are provided by multi-beam space time coding, coupled with Orthogonal Frequency Division Multiplex (OFDM) modulation with a dispersion capability of 10 microseconds in both directions.

The 45 Mbps Backhaul has been developed to operate within license exempt frequency bands, for example the ETSI 5.8 GHz C band (5.725–5.850 GHz) and the USA 5 GHz ISM band (5.725-5.850 GHz). The 45 Mbps Backhaul has been designed to coexist with other users of the band in an optimal fashion using a combination of Transmit Power Control (TPC), Dynamic Frequency Selection (DFS) and Antenna beam shape.

In order to maintain link availability, the product employs adaptive modulation techniques that dynamically reduce the data rate in severe or adverse conditions. To the data network the 45 Mbps Backhaul is implemented as a learning bridge. A learning bridge builds up a picture 102of which addresses are connected to which port. This means that it will not bridge a packet if it knows that the destination address is connected to the same port on which the bridge saw the packet. Figure 5 illustrates the 45 Mbps Backhaul layer diagram.

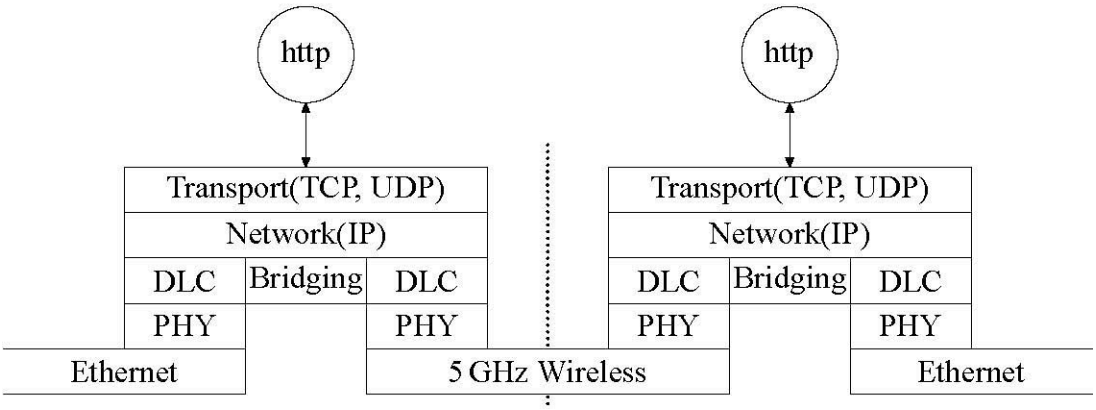

Figure 5 45 Mbps Backhaul Layer Diagram

The 45 Mbps Backhaul functionality has been extended to encompass the IEEE 802.1q sub specification IEEE 802.1p. IEEE 802.1p allows the Ethernet packets to be extended by 4 bytes to include the IEEE 802.1q VLAN Tag and VLAN Priority/ID with VLAN ID set to 0 and the packet priority set to 0-7. The 45 Mbps Backhaul will forward all VLAN tagged packets regardless of the VLAN ID value. Packets with a value of Priority greater than 0 will be given priority over other packets.

Each unit in the link is manageable through an IP connection. Standard IP protocols are utilized for all management functions e.g. HTTP, SNMP, etc.

The 45 Mbps Backhaul is fully software upgradeable. New software images are first download from the Motorola website http://www.motorola.com/canopy to a convenient computer. The image is then uploaded to the ODU via the web management page described in section 6.3.4 “Software Upgrade”. The compressed image is first loaded into RAM and check-summed. If the compressed image transfer has completed successfully the image is decompressed and written to Flash memory. On completion of this process the unit can be rebooted to use the newly uploaded image. Should this process fail the unit will revert to a protected compressed image installed during manufacturing to allow the unit to be recovered.

3 General Considerations

3.1 Frequency Planning

The 45 Mbps Backhaul operates over the frequency range 5.725 to 5.850 GHz (defined as the USA ISM band and the ETSI 5 GHz C band), utilizing a 11 MHz wide channel. Setting of the operating frequency channel is automatic and is carried out by the built in Dynamic Frequency Selection (DFS) functionality.

The user can configure the 45 Mbps Backhaul to avoid using certain frequencies to prevent interference to other users of the band and prevent operation in parts of the band containing interference. The use of this functionality is described in detail in section 6.3.5 “Spectrum Management”.

3.2 Distance

The 45 Mbps Backhaul will operate at ranges from 100 m to 200 km, this within 4 modes 0-5km, 0-40km, 0-100km, and 0-200km. Operation of the system will depend on obstacles in the path between the units. Operation at 40 km or above will require a near Line-of-Sight path. Operation at 100m could be achieved with one unit totally obscured from the other unit, but with the penalty of transmitting at higher power in a non-optimal direction, thereby increasing interference in the band. This subject is covered in more detail in section 4.1.3 “Path Loss Considerations”.

3.3 Networking Information

The 45 Mbps Backhaul operates as a transparent Ethernet bridge. Each unit requires an IP address. This IP address is for management purposes only and it plays no part in the operation of the system. IP addresses are assigned during initial configuration as described in section 5.2 “Installation Procedure”.

3.4 Lightning Protection

The amount of lightning protection is dependent on regulatory requirements and the end user requirements. The standard 45 Mbps Backhaul ODU is fitted with surge limiting circuits and other features to minimize the risk of damage due to nearby lightning strikes. These standard features may require some additional equipment to be configured as part of the system installation to be fully effective. Motorola recommends the use of shielded cable and surge arrestor to protect connected equipment from nearby strikes.

Note: The 45 Mbps Backhaul is not designed to survive direct lightning strikes. For this reason the unit should not be installed as the highest point in a localized area, unless specific precautions are taken. See section 9 “Lightning Protection”.

3.5 Electrical Requirements

The 45 Mbps Backhaul is supplied with a variable input voltage (90-264V, 47-63Hz AC) inline power supply unit which is incorporated into the Power Indoor Unit (PIDU). The 45 Mbps Backhaul requires one mains AC power outlet at each end of the link.

4 Site Planning

4.1 Site Selection Criteria

The following are guidelines for selecting the installation location of the 45 Mbps Backhaul ODU and PIDU.

4.1.1 ODU Site Selection

When selecting a site for the ODU the following should be taken into consideration:

- That it is not possible for people to stand or walk inadvertently in front of the antenna.
- Height and location to achieve the best radio path
- Height in relation to other objects with regard to lightning strikes
- Protection from the weather
- Aesthetics and planning permission issues
- Distance from PIDU and connected equipment (Maximum cable run ODU to connected equipment is 328 ft (100m))
- Distance from the PIDU to the ODU (Maximum cable run PIDU to ODU is 328 ft (100m))

4.1.2 PIDU Site Selection

When selecting a site for the PIDU the following should be taken into consideration:

- Availability of a mains electricity supply
- Accessibility for viewing status indicators and pressing reset switch (See section 1.3.2 “The Power Indoor Unit (PIDU)” and section 7 “Fault Finding”
- Distance from ODU and connected equipment (Maximum cable run ODU to connected equipment is 328 ft (100m))
- Distance from the ODU to the PIDU (Maximum cable run ODU to PIDU is 328 ft (100m))

4.1.3 Path Loss Considerations

The path loss is the amount of attenuation the radio signal undergoes between the two ends of the link. The path loss is the sum of the attenuation of the path if there were no obstacles in the way (Free Space Path Loss), the attenuation caused by obstacles (Excess Path Loss) and a margin to allow for possible fading of the radio signal (Fade Margin).

$$L_{free\_space} + L_{excess} + L_{fade} + L_{season} < L_{capability}$$

Where	Is
L_{free_space}	Free Space Path Loss (dB)
L_{excess}	Excess Path Loss (dB)
L_{fade}	Fade Margin Required (dB)
$L_{seasonal}$	Seasonal Fading (dB)
$L^{capability}$	Equipment Capability (dB)

Equation 1 Path Loss

4.1.4 Aggregate Ethernet throughput rate v maximum link loss

The equipment capability is given in Table 2. It gives the Ethernet throughput rate vs link loss for 45 Mbps Backhaul in both modes. Adaptive modulation will ensure that the highest throughput that can be achieved instantaneously will be obtained taking account of propagation and interference. The calculation of Equation 1 needs to be performed to judge whether a particular link can be installed. When the link has been installed web pages provide information about the link loss currently measured by the equipment both instantaneously and averaged. The averaged value will require maximum seasonal fading to be added and then the radio reliability of the link can be computed.

Aggregate Ethernet Throughput Rate (Mbps)[1]				**Maximum path budget[2] (dB)**
0-5km (0-3 miles) Mode	**0-40km (0-25 miles) Mode**	**0-100km (0-62 miles) Mode**	**0-200km (0-124 miles) Mode**	
33.75	31.59	28.46	24.43	138.1
28.92	27.07	24.39	20.94	142.8
25.71	24.06	21.68	18.61	144.7
19.28	18.05	16.26	13.96	150.1
12.86	12.03	10.84	9.30	154.6
8.57	8.02	7.23	6.20	159.2
6.43	6.02	5.42	4.65	161.3
3.21	3.01	2.71	2.33	166.5

Table 2 Aggregate Ethernet throughput rate v maximum link loss

The full calculation is relatively complicated, and so a link estimator tool is available that calculates the radio propagation and reliability of NLOS links using the 45 Mbps Backhaul equipment.

4.2 Collocating Backhauls

The Canopy 45 Mbps Backhaul can be collocated on the same mast or tower or building as other Canopy modules operating in the 5.7 GHz frequency band. Following only three design rules will often give full performance. Additional interference mitigation design may be needed in some cases, depending on the RF environment.

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[1] Throughput based on 1518 Byte Ethernet Packets on a symmetrical link.

[2] AMOD link margin of 1.5 dB applied.

4.2.1 Rules for Collocating

To collocate Canopy 45 Mbps Backhauls and Canopy 5.7 GHz 10 or 20 Mb Backhauls, follow these three rules:

- Use a minimum vertical separation of 6 ft (1.8 m) between the 45 Mbps Backhaul and any other Canopy module.
- Use 5735, 5755, and 5775 MHz for the 5.7 GHz Access Points or 10 Mb or 20 Mb backhauls.
- Either let the 45 Mbps Backhaul(s) use dynamic frequency selection to select the highest capacity frequency available, or manually select 5800, 5806, 5812, 5818, 5824, 5830, 5836, or 5842 for the 45 Mbps Backhaul(s).

Note, 100 vertical feet (30 vertical meters) of distance separation is still required between 10 or 20 Mbps Backhauls and Access Points operating in the same frequency band.

4.2.2 Additional Information for Collocating

The Canopy 45 Mbps Backhaul and other Canopy Backhauls each have their individual frequency constraints. For example, the 45 Mbps Backhaul employs a sophisticated dynamic frequency selection (DFS) capability. This allows it to automatically select the highest-capacity frequency currently available for the link. However, DFS becomes less effective as the spectrum becomes more crowded. In crowded environments, manual frequency selection may be required to extract the very best performance from the units. DFS measurements are still very useful, however, because they provide the measurements to confirm that the optimum arrangement has been achieved.

Access Point clusters typically use three frequencies 20 MHz apart. In a six-sector base station, these frequencies are typically reused with the same frequency being used in back-to-back sectors. For collocation, use one end of the band for the Access Point cluster (or 10 Mb or 20 Mb Backhauls), and the other end of the band for the 45 Mbps Backhaul(s), with at least 25 MHz between the top group of frequencies and the bottom group of frequencies. The recommended frequencies for the AP cluster are 5735, 5755, and 5775 MHz. Given these frequencies and a minimum vertical separation of 6ft (1.8m) then the 45 Mbps Backhaul can operate on 5800, 5806, 5812, 5818, 5824, 5830, 5836, or 5842.

5 Installation

Motorola recommends that only qualified personnel undertake the installation of an 45 Mbps Backhaul system.

5.1 Preparation

Before proceeding with the installation you should:

- Check the contents of all packages against the parts lists shown in the packing list.
- Ensure that you have the correct tools for the job.
- Ensure that you are qualified to undertake the work.
- Ensure that you have taken the correct safety precautions.
- Have completed the site planning as described in section 4 “Site Planning”.

5.2 Installation Procedure

The 45 Mbps Backhaul installation procedure consists of the following steps:

- Mounting the ODUs, section 5.6
- Connecting up, section 5.7
- Mounting the PIDUs, section 5.7.7
- Powering Up, section 5.7.8
- Aligning the ODUs, section 5.7.9

5.3 Tools Required

The following specific tools are required to install the 45 Mbps Backhaul in addition to general tools:

- Two 13mm Spanners / Wrenches
- RJ45 Crimp Tool
- IBM Compatible Personal Computer (PC) running Windows 98 or later with 10 or 100baseT Ethernet (Ability to change IP settings easily is recommended)
- Either Internet Explorer version 6 or higher, or Netscape Navigator 7.01 or higher are recommended.
- 2 x short Ethernet patch cables
- 6mm general purpose crimp tool for the grounding lug (optional for lightning Protection)

5.4 Installation Support

For installation support, first contact your supplier or reseller, then escalate as needed to Canopy Technical Support.

A Frequently Asked Questions (FAQ) section can be found in section 11.8.

5.5 Legal Disclaimer

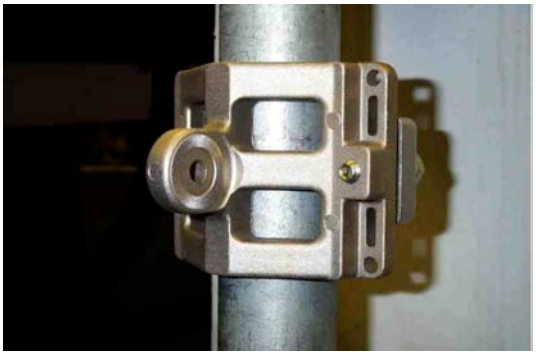
IN NO EVENT SHALL MOTOROLA BE LIABLE FOR ANY INJURY TO ANY PERSONS OR ANY DAMAGE CAUSED DURING THE INSTALLATION OF THE MOTOROLA 45 Mbps Backhaul PRODUCT.

5.6 Mounting the ODUs

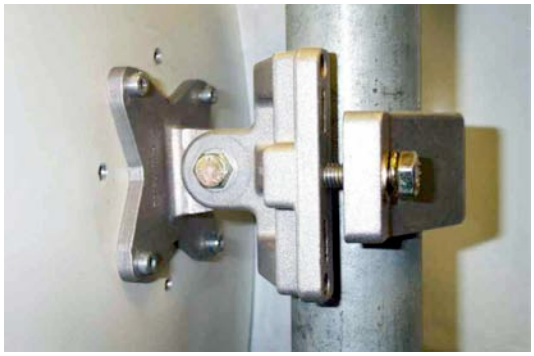
The ODU mounting bracket is designed to ease installation by mounting the bracket to a wall or pole and then bringing the ODU into position and attaching using a single bolt. The ODU should be mounted using the following steps ensuring that the cable entry is at the bottom: NOTE: There should be no reason to change the orientation of the pre-fitted ODU bracket for either pole or wall mount, provided the fitting instructions are followed.

The enclosure and mounting brackets of the ODU are capable of withstanding wind speeds up to 151mph (242kph). The installer should ensure that the structure the ODU is attached to is also capable of withstanding the prevalent wind speeds and loads. See Section 10 “Wind Loading”.

5.6.1 Pole Mounting



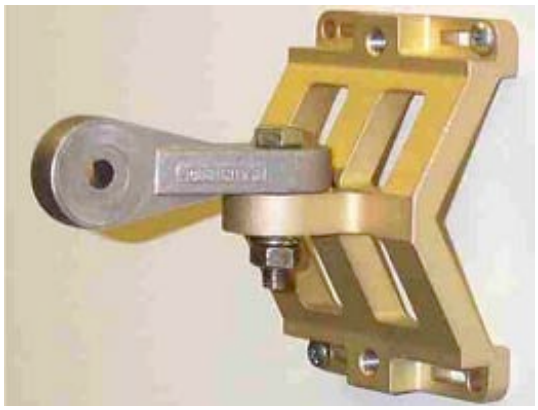
Step 1: Mount the bracket to the pole.



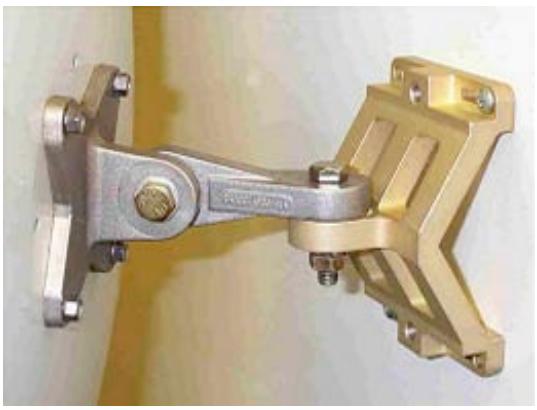
Step 2: Mate the unit to the bracket together and tighten the nut and bolt.

5.6.2 Wall Mounting

Select and use high quality wall mounting hardware. Note that wind loading can be very high (many times the weight of the unit) depending upon the location chosen. Also ensure that the wall can withstand these high forces.



Step 1: Mount one half of the bracket to the wall.



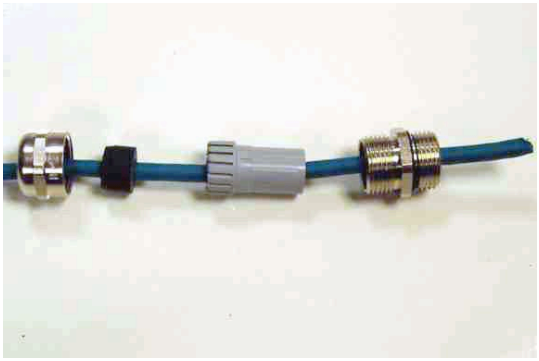
Step 2: Mate the two halves of the bracket together and tighten the nut and bolt.

5.7 Connecting Up

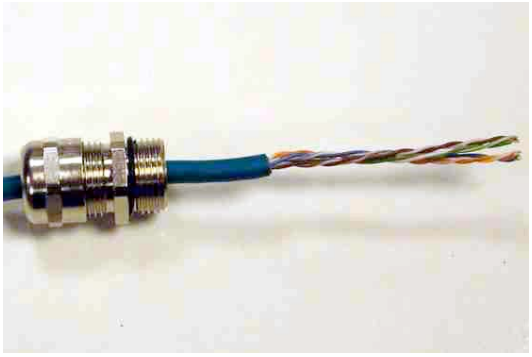
5.7.1 Preparing The Cable — RJ45 connections

Cable can be purchased from your reseller or distributor. (Note that the maximum length between the PIDU and ODU is 100m.) Those wishing to source their own cables and connectors (see section 1.3.4 “Cables and Connectors”) should use the following instructions along with the cable and connector suppliers instructions.

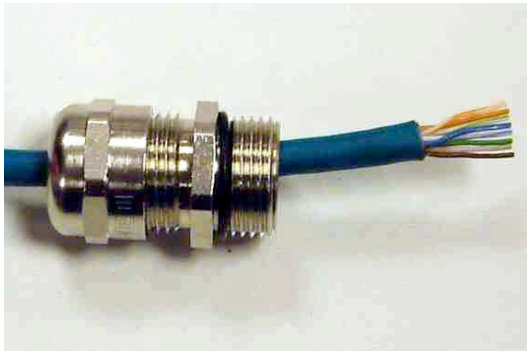
Important! The cable must be threaded through the weatherproofing gland **before** crimping on the RJ-45 connector. An RJ-45 connector will not fit through the clamping ring of the weatherproofing gland.



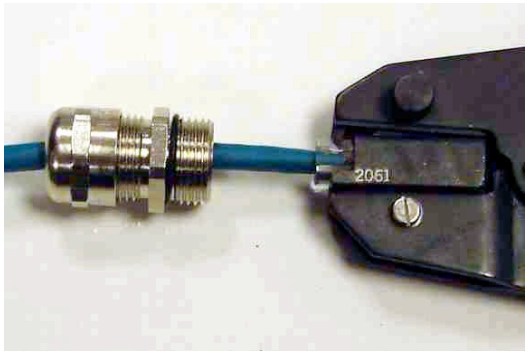
Step 1: Assemble weatherproofing gland on cable as shown



Step 2: Strip the outer insulation



Step 3: Arrange conductors as shown in Figure 7 and cut to length



Step 4: Insert conductors and crimp

Figure 6 Completed ODU connector

Both ends of the ODU cable are terminated in the same way. Repeat steps 2, 3, and 4 for the PIDU end of the cable. Note: The PIDU end of the cable does not employ a cable gland.

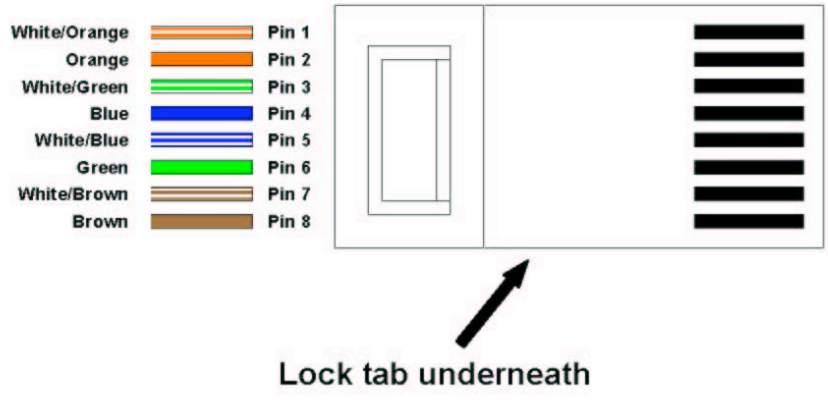


Figure 7 RJ45 Pin Connection

5.7.2 Making the Connection At The ODU

The following procedure describes how connection is made at the ODU. It is often easier to carry out this procedure on the ground or a suitable surface prior to mounting the ODU.

Ensure no power is connected to the PIDU or present on the cable before connecting the ODU.

Step 1: Assemble the cable as described in 5.7.1

Step 2: Insert the RJ45 connector making sure that the locking tab snaps home

Step 3: Screw in the body of the weather proofing gland and tighten

Step 4: Screw on the clamping nut and tighten

Should it be necessary to disconnect the PIDU to ODU cable at the ODU this can be achieved by removing the weather proofing gland and depressing the RJ45 locking tab with a small screwdriver as shown below:

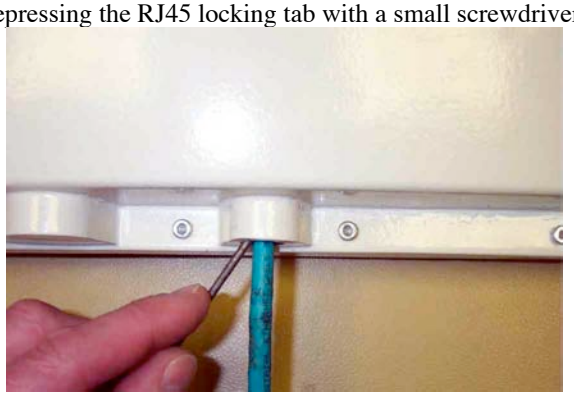


Figure 8 Disconnecting the ODU

Warning: Ensure that power is removed from the system at the PIDU to prevent damage to the ODU while making or breaking the connection.

5.7.3 Routing the Cable

After connecting the cable to the ODU it can be routed and secured using standard cable routing and securing techniques. When the cable is in place it can then be cut to the desired length at the PIDU prior to connection to the PIDU.

5.7.4 Fitting A Surge Arrestor

If you have opted to fit a Surge Arrestor, this should be installed by following the manufacturers instruction. For recommended types see Section 9 “Lightning Protection”

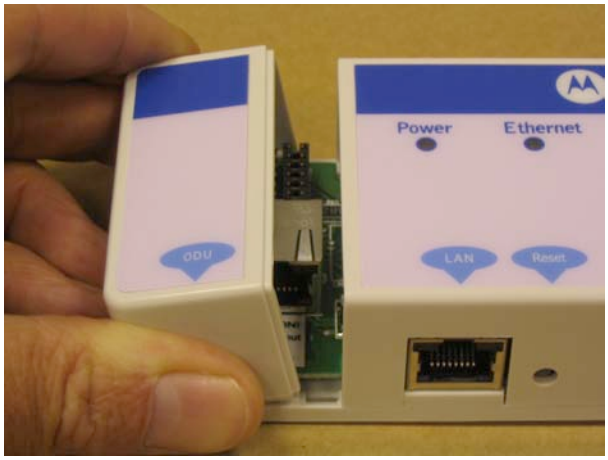
5.7.5 Grounding The Installation

The ODU must be properly grounded to protect against power surges. It is the user’s responsibility to install the equipment in accordance with Section 810 of the National Electric Code, ANSI/NFPA No.70-1984 or Section 54 of the Canadian Electrical Code or the National Electrical Code in the country of installation. These codes describe correct installation procedures for grounding the outdoor unit, mast, lead-in wire and discharge unit, size of grounding conductors and connection requirements for grounding electrodes. Installation of the ODU should be done by a professional installer familiar with codes and safety practices. See Section 9 “Lightning Protection” for recommended grounding kits.

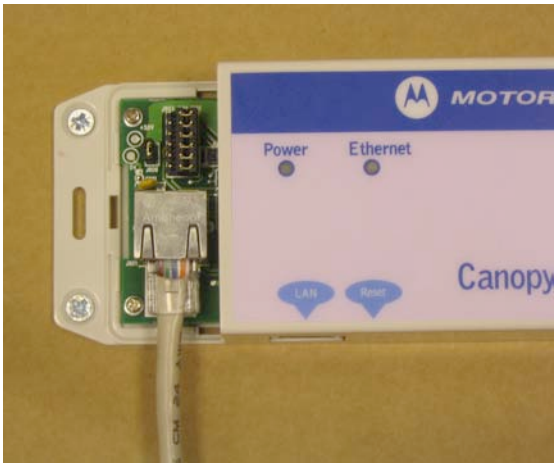
5.7.6 Making the Connection At The PIDU

The ODU is connected to the PIDU by means of a concealed RJ45 connector. The RJ45 connection has been placed inside the PIDU removable cover to prevent the user inadvertently plugging other equipment into the ODU RJ45 socket.

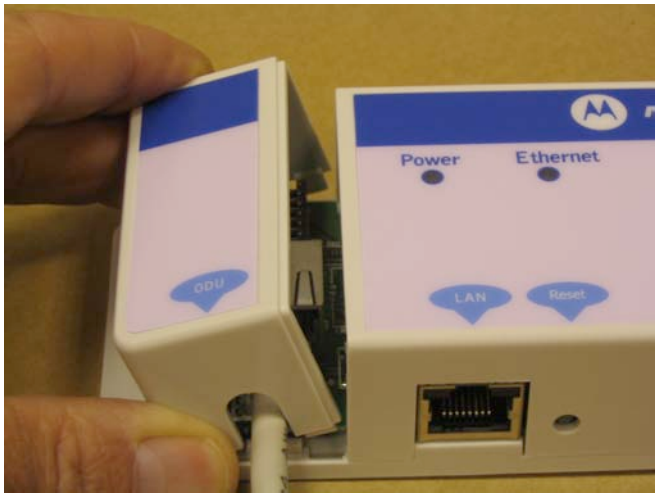
Warning: Plugging other equipment into the ODU RJ45 socket may damage the equipment due to the non-standard Power-over-Ethernet techniques employed. Plugging the ODU into other equipment may damage the ODU and/or the other equipment.



Step 1: Remove the cover by squeezing the sides and rotating away from the PIDU.



Step 2: Plug in the ODU to PIDU Cable ensuring that it snaps home



Step 3: Replace the cover ensuring it is firmly latched

5.7.7 Mounting The PIDU

This step is optional. Motorola recommends that you mount the PIDU on a wall or other suitable mounting surface. This prevents the unit from being knocked or kicked and can help maintain link availability. Ensure that the reset switch can be accessed when mounting the unit.

Step 1: Fix the PIDU to the wall using the lugs provided.

Step 2: Make connections as per Section 5.7.6

5.7.8 Powering Up

The Canopy 45 Mbps Backhaul system is supplied as a pair of matched Master/Slave units. The Master unit to be configured can now be powered up and accessed using the default URL http://169.254.1.2; the Slave unit can be accessed using http://169.254.1.1.

Prior to powering up the 45 Mbps Backhaul, a computer with web browsing capabilities should be configured with an IP address of 169.254.1.n and subnet mask of 255.0.0.0 where n is any value between 1 and 254 but excluding 1 or 2. If the default address of the unit 169.254.1.1/2 clashes with an address you are already using on your LAN, or you are not sure, you should set up an isolated LAN. As the LAN connection presented at the PIDU has a default configuration as a hub/switch (and auto-sensing MDI/MDIX cross over is employed) connection can be made directly to the computer using a standard CAT 5 patch cable.

Before physical installation takes place the units to be installed should be set up as described in the section 6.3.3. This process will give the installer the opportunity to set the units IP address to one that is in the desired address range and set each unit up with the MAC address of its peer unit ready to establish a radio link. It is recommended that this procedure be carried out on the bench before physical installation commences. Providing it is safe to do so the installer should take the process to the point where a radio link is established before proceeding to the installation site.

5.7.9 Aligning the ODUs

The following is a description of the steps taken to establish a radio link between the two units forming the bridge and align the units for the best signal strength.

The 45 Mbps Backhaul uses audible tones during installation to assist the installer with alignment. The installer should adjust the alignment of the ODU in both azimuth and elevation until highest pitch tone is achieved[3]. The tones and their meanings are as follows:

State Name	Tone Description	State Description	Pitch Indication (Higher pitch = higher power)
Band Scan	Regular beep	Executing band scan	N/A
Scanning	Slow broken tone	Not demodulating the wanted signal	Rx Power
Synchronized	Fast broken tone	Demodulating the wanted signal	Rx Power
Registered	Solid tone	Both Master and Slave units exchanging Radio layer MAC management messages	Rx Power

Table 3 Audio indications from the ODU

The term 'wanted signal' refers to that of the peer unit being installed.

In each of the states detailed above the unit should be aligned to give the highest pitch tone. It should be noted that if, when in the Synchronized or Registered state the tone varies wildly, you may be suffering from interference or a fast fading link. Installing in this situation may not give a reliable link. The cause of the problem should be investigated.

For the ease of alignment both Master and Slave units use the install tones in the same way but with some small behavioral differences. This allows the installer to install the Slave unit first and carry out the initial alignment with the Master unit if desired. However due to the Behavioral differences of Master and Slave units it is recommended that the Master unit is installed first and the initial alignment carried out at the Slave unit.

The following behavior should be noted:

When first started up and from time to time the Master unit will carry out a band scan to determine which channels are not in use. During this time, between 10 and 15 seconds, the Master unit will not transmit and as a consequence of this neither will the Slave unit. During this time the installation tone on the master unit will drop back to the band scan state and the Slave unit will drop back to Scanning state with the pitch of the tone set be the background noise level. Alignment of the unit should cease during this time.

The master unit can take between 10 seconds in 0-5km mode to 60 seconds in 0-200km mode to determine the range of the link being installed[4]. The Master unit will remain in the Scanning state until the range of the link

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[3] The pitch of the alignment tone is proportional to the power of the 5.8 GHz wireless signals. The best results are usually achieved by making small incremental movement in angular alignment.

has been established. The Master unit will only move to the Synchronized state when the range of the link has been established.

If at the end of the ranging period the Registered state is not achieved due to interference or other reasons, the Master unit will retry twice more on the same channel before moving to another available channel. Should this occur it might take a number of minutes to establish a link in the Registered state.

The Slave unit does not have a ranging process. The slave unit will change to the Synchronized state as soon as the wanted signal is demodulated.

When the alignment process is complete the installer MUST REMEMBER TO DISARM BOTH UNITS in the link as described in section 6.3.3. This is necessary for the following:

- Turn off audible alignment aid.
- Enable Adaptive Modulation
- Fully enable Dynamic Frequency Selection[5]
- Clear unwanted installation information from the various systems statistics
- Store the link range for fast link acquisition on link drop
- Enable Higher Data Rates

[4] If the unit is operating in region 4 (the UK) the radar avoidance algorithms may affect the ranging behavior for the 45 Mbps Backhaul. If a radar is detected during any of the installation phases a compulsory 60 seconds channel scan will take place as the master unit attempts to locate a new channel.

[5] Full Dynamic Frequency Selection is not available in region 4 (the UK).

6 Web Page Reference

The web user interface has three main sections. The home page presents to the operator a high level summary of the 45 Mbps Backhaul wireless link. The status page presents a more detailed set of system parameters describing the performance of the wireless link together with other key system performance metrics. The final section is the system administrator section. This section is password protected and allows the 45 Mbps Backhaul administrator to perform all the day-to-day administrative procedures, e.g. Software Upgrade and perform configuration changes.

The following subsections give a detailed usage guide for all the web user interfaces.

The navigation bar on the left hand side of the web page is used to move between the various management pages. The currently selected page is always highlighted with a light yellow background. The menu is hierarchical. Selecting any menu item which has associated submenu options will automatically display all sub options. An example webpage with the navigation menu is shown in Figure 9 where the 'Home' link is highlighted as the current page.

6.1 Home Page

The 45 Mbps Backhaul home page has been designed to display a high level summary of the status of the wireless link and associated equipment. The home page (Figure 9) normally displays four key system attributes:

Wireless Link Status The Wireless Link Status attribute as the name suggests displays the current status of the 45 Mbps Backhaul wireless link. A state of 'Up' on a green background indicates that a Point-to-Point link is established. A state of 'Down' on a red background indicates that the wireless link is not established. If the link is down for an unknown reason the system administrator should first consult the status web page for a more detailed summary of up to date system diagnostics.

Link Name The link name attribute is a name and/or handle allocated by the system administrator to aid the identification of the unit, network or building.

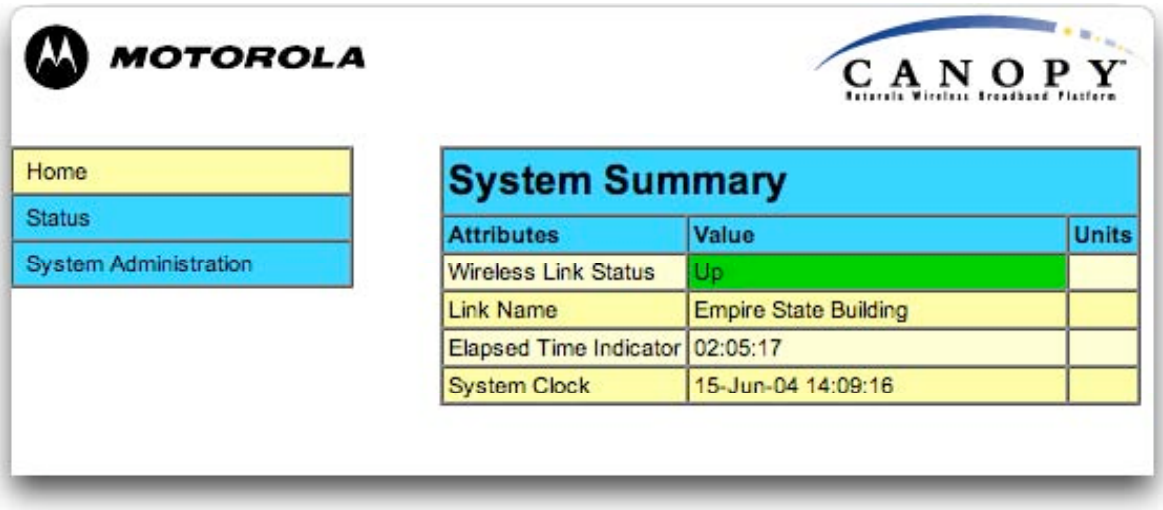


Figure 9 45 Mbps Backhaul Home Page

Elapsed Time Indicator The elapsed time indicator attribute presents the total time in days, hours, minutes and seconds since the last system restart. The system can restart for several reasons, e.g. commanded reboot from the system reboot webpage, or a power cycle of the equipment.

System Clock If the SNTP (Simple Network Time Protocol) (see section 6.3.8.3) is enabled a system clock attribute is displayed giving the date and time of the last page refresh. If SNTP is disabled then the system clock attribute is not displayed on the home page.

6.1.1 Home Page Alarm Display

The home page is also used to display all outstanding major system alarms. Whenever system alarms are asserted a yellow warning triangle is displayed on webpage navigation bar. The warning triangle will be visible from all webpages. Clicking the warning triangle will cause the webpage to jump back to the system homepage. Figure 10 shows an example alarm screen.

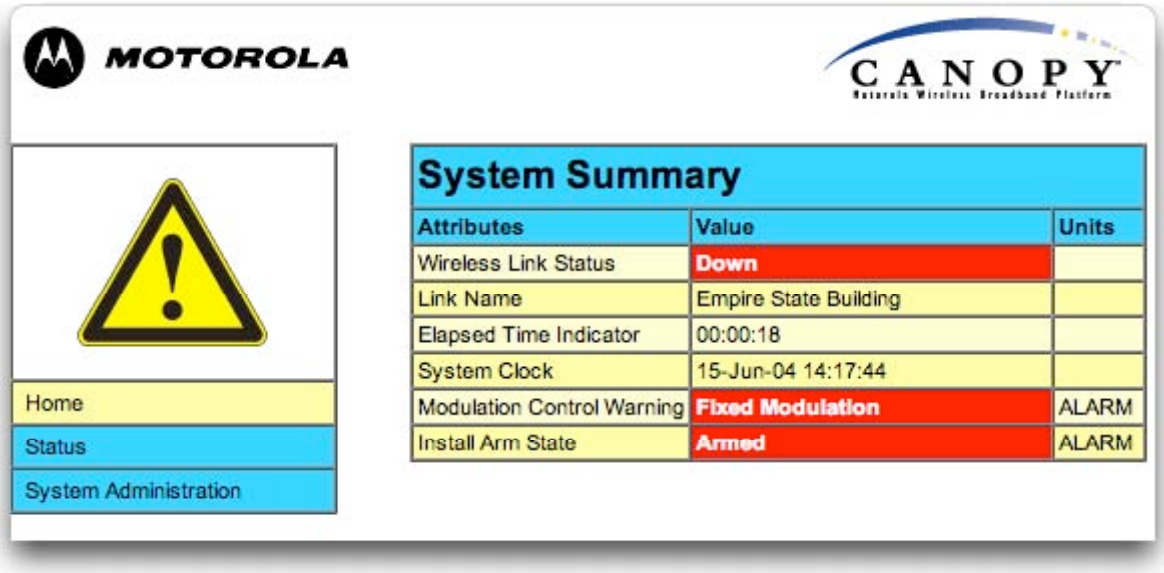


Figure 10: Alarm Warning Triangle

The following major system alarms are defined:

Install Arm State The Install Arm State alarm is displayed. This alarm warns when a wireless unit is in installation mode. After installation the wireless unit should be disarmed. This will increase the wireless links data carrying capacity and stop the installation tone generator. The wireless link is disarmed from the 'Installation Wizard.' See section 6.3.3.

Install Status If any errors are detected during the installation process, the unit will automatically raise an audible alarm. The install status alarm will be raised with an appropriate reason code, e.g. the alarm will be raised if an incorrect target MAC address is specified for the peer 45 Mbps Backhaul wireless unit.

ARQ Is Not Configured ARQ must be enabled on both ends of the Point-to-Point link. This error message is generated if there is a mismatch in the ARQ settings between both ends of the link.

Encryption Is Not Configured On Both Units Encryption must be enabled on both ends of the Point-to-Point link before the over the air packets can be successfully decrypted. This error message is generated if encryption is not configured on both units.

Ethernet Link Status If there are any problems with the Ethernet interface this alarm will be asserted. This alarm will most likely seen if the unit has not got an Ethernet cable plugged into its Ethernet socket.

Master And Slave Have Incompatible Region Codes The 45 Mbps Backhaul uses region codes to comply with local regulatory requirements governing the transmission of wireless signals in the 5.8 GHz band. Region codes can only be changed by obtaining a new 45 Mbps Backhaul license key. If this alarm is encountered the

appropriate license keys from the country of operation should be obtained from your distributor. Applying license keys containing the same region codes to both ends of the link will remove the alarm.

Spectrum Management Channel Warning The alarms warns a user when the intelligent spectrum management feature can't find a suitable wireless channel. This alarm occurs when the signal assessment features of the 45 Mbps Backhaul can't find a channel to operate on.

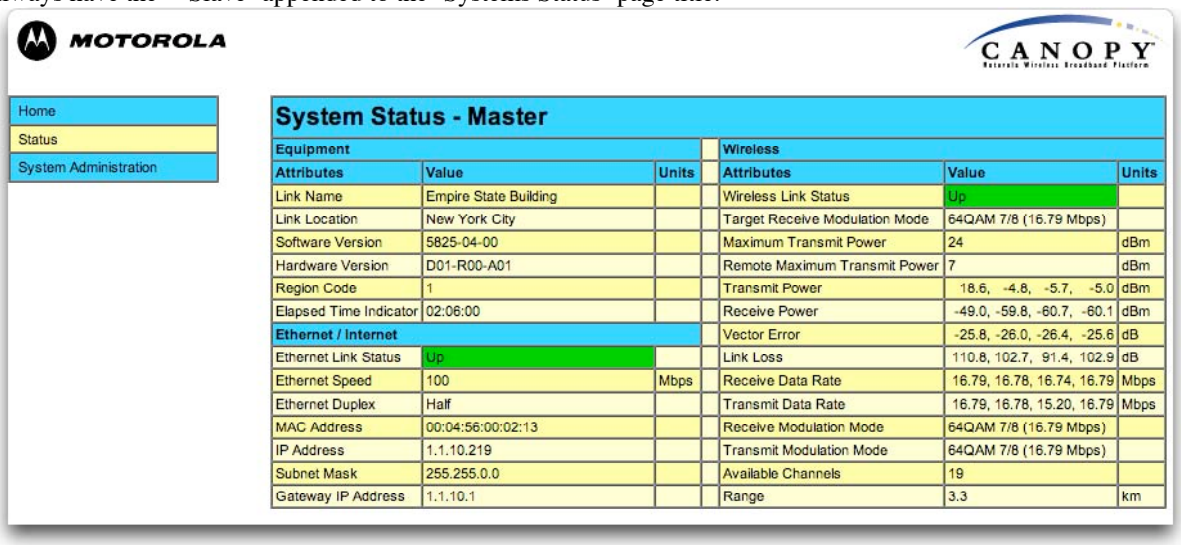
6.2 Systems Status Page

The status page has been designed to give the system administrator a detailed view of the operation of the 45 Mbps Backhaul system from both the wireless and network perspectives.

The page is subdivided into three main categories Equipment, Wireless and Ethernet/Internet. The 'Equipment' section contains all the unit's inventory and identification information. The 'Wireless' section presents all the key wireless metrics displayed as a series of measurements and histograms. The 'Ethernet/Internet' section describes the unit's network identity and connectivity.

The status page can be configured to refresh itself at an operator defined rate (if the user is logged in a system administrator). The refresh period the page field defaults to is 3600 seconds and can easily be changed to refresh at any period between 2 seconds and 3600 seconds. Pressing the 'Update Page Refresh Period' button causes a new page refresh period to be adopted by the system. The page refresh mechanism uses a HTML Meta refresh command. Therefore the refresh is always initiated by the local browser and not by the 45 Mbps Backhaul system at this interval.

The two 45 Mbps Backhaul units are arranged in a master and slave relationship. The units' role in this relationship is displayed in the page title. The master unit will always have the title '- Master', and the slave will always have the '- Slave' appended to the 'Systems Status' page title.



System Status - Master

Equipment			Wireless		
Attributes	Value	Units	Attributes	Value	Units
Link Name	Empire State Building		Wireless Link Status	Up	
Link Location	New York City		Target Receive Modulation Mode	64QAM 7/8 (16.79 Mbps)	
Software Version	5825-04-00		Maximum Transmit Power	24	dBm
Hardware Version	D01-R00-A01		Remote Maximum Transmit Power	7	dBm
Region Code	1		Transmit Power	18.6, -4.8, -5.7, -5.0	dBm
Elapsed Time Indicator	02:06:00		Receive Power	-49.0, -59.8, -60.7, -60.1	dBm
Ethernet / Internet			Vector Error	-25.8, -26.0, -26.4, -25.6	dB
Ethernet Link Status	Up		Link Loss	110.8, 102.7, 91.4, 102.9	dB
Ethernet Speed	100	Mbps	Receive Data Rate	16.79, 16.78, 16.74, 16.79	Mbps
Ethernet Duplex	Half		Transmit Data Rate	16.79, 16.78, 15.20, 16.79	Mbps
MAC Address	00:04:56:00:02:13		Receive Modulation Mode	64QAM 7/8 (16.79 Mbps)	
IP Address	1.1.10.219		Transmit Modulation Mode	64QAM 7/8 (16.79 Mbps)	
Subnet Mask	255.255.0.0		Available Channels	19	
Gateway IP Address	1.1.10.1		Range	3.3	km

Figure 11 Status Page

The following section details all the attributes displayed on the status page.

Link Name The link name is allocated by the system administrator and is used to identify the equipment on the network. The link name attribute is to a maximum size of 63 ASCII characters.

Link Location The link location is allocated by the system administrator and can be used as a generic scratch pad to describe the location of the equipment or any other equipment related notes. The link location attribute is limited to a maximum size of 63 ASCII characters.

Software Version The attribute describes the version of software installed on the equipment. The format of the attributes is *PPPP-XX-YY* where *PPPP* is the product version, *XX* is the major release version and *YY* is the minor release version.

Hardware Version The hardware version attribute contains all the combined hardware version information. The attribute is formatted as D*XX*.-R*YY*-A*ZZ* where D*XX* contain the version of the digital card, R*YY* contains the version of the RF (radio frequency) card and A*ZZ* describes the antenna type.

Region Code The region code is used by the system to constrain the wireless to operate within the 5.8 GHz regulatory regime of the particular country. The region code is encoded in the product license key. If the operator wishes to change region code, a new license key must be obtained from Motorola or the local distributor / system integrator.

Elapsed Time Indicator The elapsed time indicator attribute presents the total time in years, days, hours, minutes and seconds since the last system restart. The system can restart for several reasons, e.g. commanded reboot from the system reboot webpage, or a power cycle of the equipment.

Ethernet Link Status Current status of the Ethernet link. A state of ‘Up’ with a green background indicates that an Ethernet link is established. A state of ‘Down’ with a red background indicates that the Ethernet link is not established.

Ethernet Speed The negotiated speed of the Ethernet interface specified in Mbps.

Ethernet Duplex The negotiated duplex of the Ethernet interface.

Full Duplex Full Duplex data transmission means that data can be transmitted in both directions on a signal carrier at the same time. For example, on a local area network with a technology that has full duplex transmission, one workstation can be sending data on the line while another workstation is receiving data.

Half Duplex Half Duplex data transmission means that data can be transmitted in both directions on a signal carrier, but not at the same time. For example, on a local area network using a technology that has half duplex transmission, one workstation can send data on the line and then immediately receive data on the line from the same direction in which data was just transmitted.

MAC Address The Medium Access Control Layer (MAC) address is used to uniquely identify the equipment on an Ethernet network.

IP Address Internet Protocol (IP) address. This address is used by the family of Internet protocols to uniquely this identify the unit on a network

Subnet Mask A subnet allows the flow of network traffic between hosts to be segregated based on a network configuration. By organizing hosts into logical groups, subnetting can improve network security and performance.

Gateway IP Address The IP address of a computer on the current network that acts as a gateway. A gateway acts as an entrance / exit to packets from / to other networks.

Wireless Link Status As the attribute name suggests displays the current status of the 45 Mbps Backhaul wireless link. A state of 'Up' on a green background indicates that a Point-to-Point link is established. A state of 'Down' on a red background indicates that the wireless link is not established. If the link is down for an unknown reason the system administrator should first consult the status webpage for a more detailed summary of the prevailing system diagnostics.

Target Receive Modulation Mode The target modulation mode is used by the wireless subsystem to control the adaptive modulation algorithm. The mode is used by the 45 Mbps Backhaul as an upper limit, the system will not move to a high rate modulation mode even if the signal / interference environment will support high rate modes.

Remote Transmit Maximum Power The maximum transmit power the remote wireless unit is permitted to use to sustain a link.

Transmit Power Transmit power histogram is expressed in dBm and presented as: max, mean, min, and latest. The histogram is calculated over a one hour period. If the equipment has been running for less than one hour then the histogram is calculated over the current elapsed time.

The data used to compute the histogram statistics can be downloaded in an ASCII command separated variable (CSV) format via the diagnostics download page, see section 6.3.9.

Receive Power Receive power histogram is expressed in dBm and presented as: max, mean, min, and latest. The histogram is calculated over a one hour period. If the equipment has been running for less than one hour then the histogram is calculated over the current elapsed time.

The data used to compute the histogram statistics can be downloaded in an ASCII command separated variable (CSV) format via the download diagnostics page, see section 6.3.9.

Vector Error The vector error measurement compares the received signal's In phase / Quadrature (IQ) modulation characteristics to an ideal signal to determine the composite error vector magnitude. The results are stored in a histogram and expressed in dB and presented as: max, mean, min and latest. The histogram is calculated over a one hour period. If the equipment has been running for less than one hour then the histogram is calculated over the current elapsed time. The expected range for Vector Error would be approximately 0dB (NLOS link operating at sensitivity limit on BPSK _) to –29dB (short LOS link running 64QAM 7/8).

The data used to compute the histogram statistics can be downloaded in an ASCII command separated variable (CSV) format via the download diagnostics page, see section 6.3.9.

Link Loss The link loss is the total attenuation of the wireless signal between the two Point-to-Point units.

The data used to compute the histogram statistics can be downloaded in an ASCII command separated variable (CSV) format via the download diagnostics page, see section 6.3.9. The link loss calculation presented below:

$$P_{ll} = P_{T_x} - P_{R_x} + 2 \cdot (g_{T_x} + g_{R_x})$$

Where	Is
P_{ll}	Link Loss (dB)
P_{T_x}	Transmit power of the remote wireless unit (dBm)
P_{R_x}	Received signal power at the local unit (dBm)
g_{T_x}, g_{R_x}	Antenna gain at the remote and local units respectively (dBi). The antenna gain of the 45 Mbps Backhaul is 23.5 dBi.

Equation 2 Link Loss

Receive Data Rate The data rate in the receive direction, expressed in Mbps and presented as: max, mean, min, and latest histogram format.

The histogram is calculated over a one hour period. If the equipment has been running for less than one hour then the histogram is calculated over the current elapsed time.

The data used to compute the histogram statistics can be downloaded in an ASCII command separated variable (CSV) format via the download diagnostics page, see section 6.3.9.

Transmit Data Rate The data rate in the transmit direction, expressed in Mbps and presented as: max, mean, min, and latest histogram format.

The histogram is calculated over a one hour period. If the equipment has been running for less than one hour then the histogram is calculated over the current elapsed time.

The data used to compute the histogram statistics can be downloaded in an ASCII command separated variable (CSV) format via the download diagnostics page, see section 6.3.9.

Receive Modulation Mode The modulation mode currently being used on the receive channel. The number in brackets after the modulation mode and coding rate string is the effective data rate available to all MAC layer protocols.

The data used to compute the histogram statistics can be downloaded in an ASCII command separated variable (CSV) format via the download diagnostics page, see section 6.3.9.

Transmit Modulation Mode The modulation mode currently being used on the transmit channel. The number in brackets after the modulation mode and coding rate string is the effective data rate available to all MAC layer protocols.

The data used to compute the histogram statistics can be downloaded in an ASCII command separated variable (CSV) format via the download diagnostics page, see section 6.3.9.

Available Channel The available channels attribute describes the number of usable channels that have been measured by the Dynamic Frequency Selection (DFS) algorithm.

Range The range[6] between the peer 45 Mbps Backhaul units.

Refresh Page Period The Status page refreshes automatically according to the setting entered here (in seconds).

[6] The 45 Mbps Backhaul displays range in km by default, if the user would prefer to display range using Miles the 'Distance Units' attribute should be set to imperial, see the "Properties" webpage section 6.3.12

6.3 System Administration Pages

The following menu options are available for the system administrator and can be password protected. Figure 12 shows the system administration login page. By default a system admin password is not set. Simply click the login button to access the system administration features.

Once the password has been set using the 'Change Password' menu item the system administration pages will only be available after the user has entered the correct password.

Figure 12 System Administration Login Page

The features that are only available to the system administrator are:

- Configuration
- Statistics
- The Installation Wizard
- Software Upgrade
- Spectrum Management including DFS
- Remote management
- Downloadable Diagnostics
- Password Management
- License Key Management
- Properties
- System Reboot

6.3.1 System Configuration Page

The configuration page (Figure 13) is used by the system administrator to configure the 45 Mbps Backhaul unit.

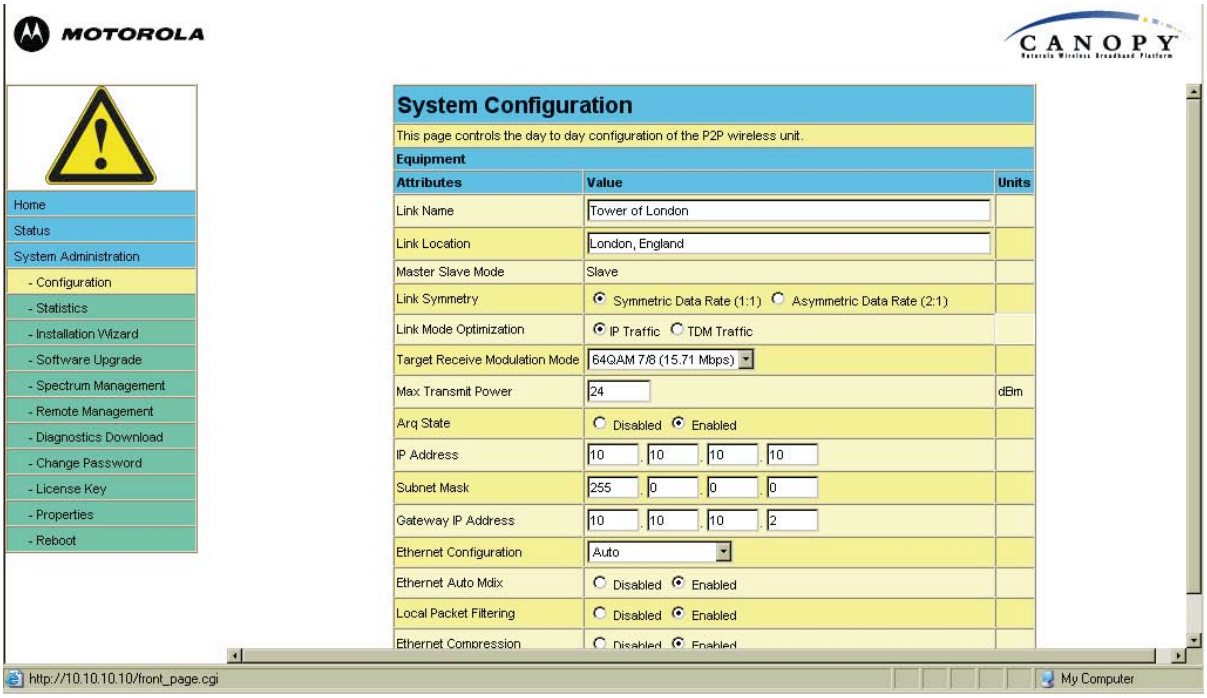


Figure 13 Configuration Page

While the majority of the system configuration is entered during installation and should never require changing, this page offers the system administrator the ability to change the basic system parameters for both the wireless and Ethernet components.

Link Name User defined identity for the unit (max 63 characters).

Link Location Can be used as a generic scratch pad to describe the location of the equipment or any other equipment related notes (max 63 characters).

Link Symmetry By default Link Symmetry of a Point-to-Point link is ‘Symmetrical Data Rate (1:1)’ in this configuration the ratio of time the wireless link spends transmitting and receiving is equal. When Link Symmetry is configured to Asymmetric Data Rate (2:1) the wireless link Master will spend twice as long transmitting as receiving. It should be noted that data rate available to the end users might not follow these ratios exactly. The exact data rates will be dependant on the prevailing modulation modes.

Target Receive Modulation Mode This is the maximum mode the unit will use as its adaptive modulation. The modulation modes available are:

- BPSK 1 / 2
- QPSK 1 / 2
- QPSK 2 / 3
- 16QAM 1 / 2
- 16QAM 3 / 4
- 64QAM 2 / 3
- 64QAM 3 / 4
- 64QAM 7 / 8

By default the Target Receive Modulation Mode is 64QAM 7/8. The value in brackets shows the maximum unidirectional data for the current modulation / ranging mode combination.

Maximum Transmit Power This specifies the maximum transmit power in dBm of the system, it is country dependent and although the user can change this it will be limited to that country's regulations.

ARQ State Automatic Repeat reQuest (ARQ) is a mechanism where packets lost due to transmission errors over the wireless link are retransmitted rapidly. The retransmission helps to prevent TCP congestion mechanisms from inadvertently interpreting intermittent packet loss as network congestion. ARQ must be enabled on both ends of the Point-to-Point link for it to function.

IP Address Internet protocol (IP) address. This address is used by the family of Internet protocols to uniquely identify this unit on a network.

Subnet Mask A subnet allows the flow of network traffic between hosts to be segregated based on a network configuration. By organizing hosts into logical groups, subnetting can improve network security and performance.

Gateway IP Address The IP address of a computer / router on the current network that acts as a gateway. A gateway acts as an entrance / exit to packets from / to other networks.

Ethernet Configuration This enables the Ethernet configuration to be forced rather than auto negotiated. The configuration should only be forced if you are having problems with auto negotiation. You must ensure that you configure both this unit and the Ethernet port to which it is connected identically. If you force a fixed Ethernet Configuration on the 45 Mbps Backhaul unit then you MUST also force the same fixed configuration on the equipment to which it is connected. If you fail to force the configuration of the connected equipment, its automatic configuration mechanisms will normally cause a duplex mismatch, and you will receive greatly reduced throughput!

Ethernet Auto Mdix This enables/disables the Auto Medium Dependent Interface (MDI)/Medium Dependent Interface Crossover (MDIX) capability.

Local Packet Filtering When Local Packet Filtering is Enabled, the bridge learns the source MAC addresses of devices transmitting Ethernet packets on the local Ethernet network, and only bridges packets to the remote unit if the destination MAC address has not been learnt as a 'local' device. When Local Packet Filtering is Disabled the bridge does not learn the source MAC addresses of devices transmitting Ethernet packets on the local Ethernet network, and bridges ALL Ethernet packets received to the remote unit. Local Packet Filtering should only be disabled when external routing hardware is present.

Ethernet Compression When Ethernet compression is enabled all compressible Ethernet packets are transmitted over the wireless link using a compressed data format. This will have the net effect of increasing wireless link traffic throughput. Because the compression techniques used in the 45 Mbps Backhaul are CPU intensive, compression is only applied to modulation modes BPSK 1/2, QPSK 1/2 and QPSK 2/3. The net effect of compression is solely dependant on the individual packet compressibility (entropy). Random data will not produce good packet compression, however ASCII text and other non random data sources will produce an acceptable level of compressibility.

All the above attributes are non-volatile, once set they will be used by the unit even after a power on reboot. A number of attributes, such as IP Address, Subnet Mask and Gateway IP Address will require a reboot before they are used. If any of these attributes are changed a reboot screen appears asking the user to verify the reboot. (see Figure 14)

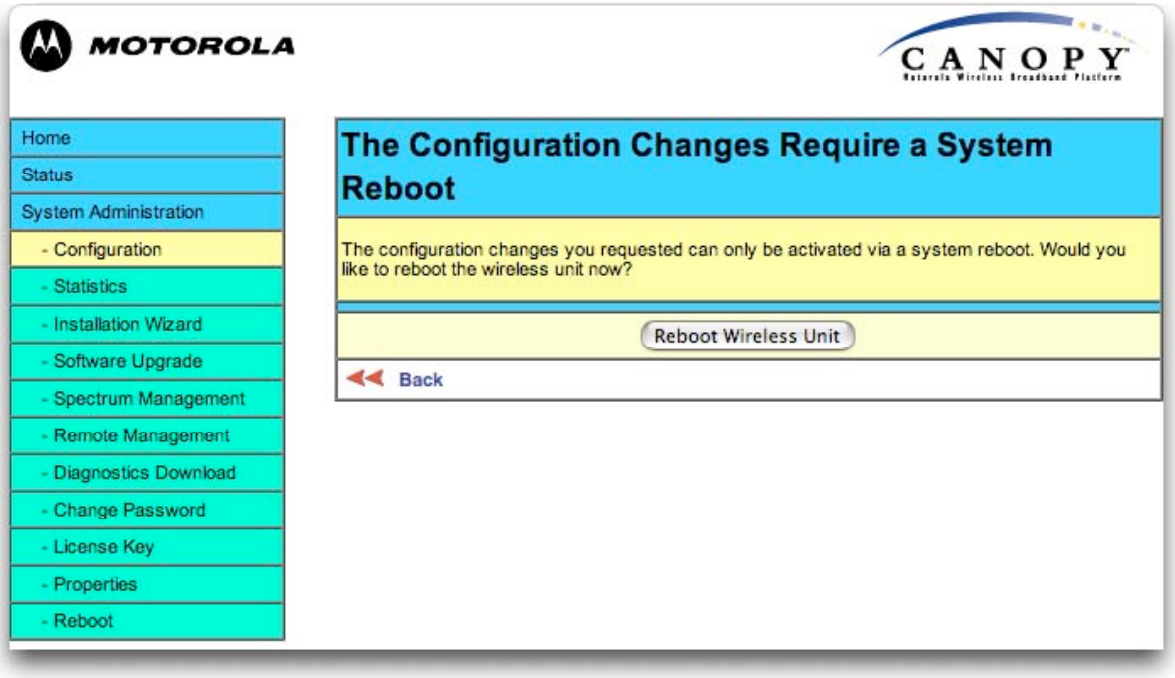


Figure 14 Configuration Reboot Page

Note: At this point you will lose connection to the unit. If you have just changed the IP Address you now have to reconnect to the unit using the address just set.

6.3.2 Statistics Page

The 45 Mbps Backhaul statistics page is designed to display some key statistics of the Ethernet Bridge and the underlying wireless performance.

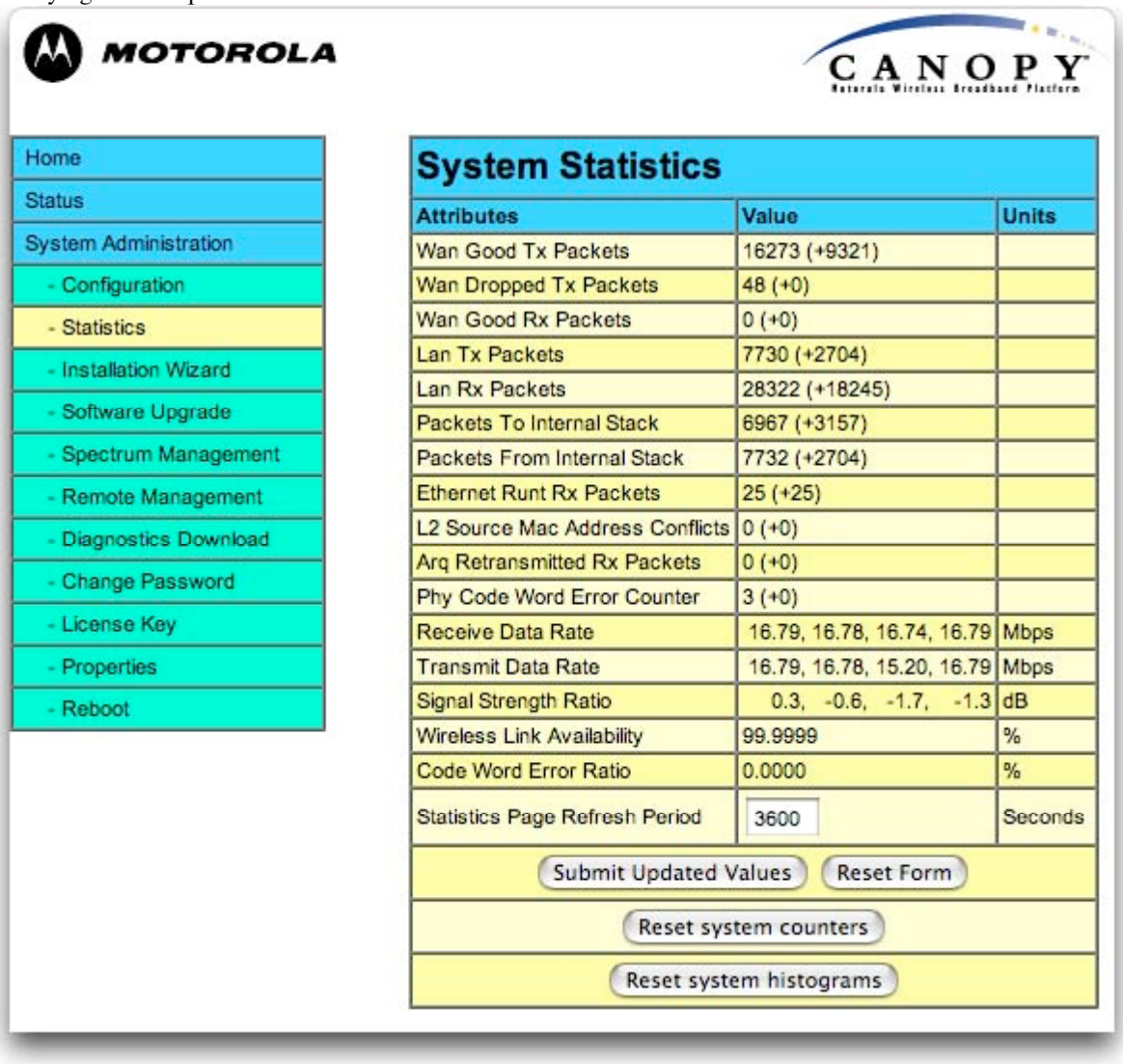


Figure 15 Statistics

Wan Good Tx Packets This displays the total number of good packets the bridge has sent for transmission by the wireless interface. The number in (+nn) displays the number of packets transmitted since the last page refresh.

Wan Dropped Tx Packets This displays the total number of packets that the local unit could not bridge to the remote unit because either the wireless link was down or because Ethernet packets are being received faster than they can be transmitted over the wireless link. The number in (+nn) displays the number of packets dropped since the last page refresh.

Wan Good Rx Packets This displays the total number of good packets the bridge has received from the wireless interface. The number in (+nn) displays the number of packets received since the last page refresh.

Wan Bad Rx Packets This displays the total number of corrupt packets the bridge has received from the wireless interface. The number in (+nn) displays the number of corrupt packets received since the last page refresh.

Lan Tx Packets This displays the total number of good packets the bridge has sent for transmission by the local Ethernet interface. The number in (+nn) displays the number of packets transmitted since the last page refresh.

Lan Rx Packets This displays the total number of good packets the bridge has received from the local Ethernet interface. The number in (+nn) displays the number of packets received since the last page refresh.

Packets To Internal Stack This displays the total number of good packets the bridge has transmitted to the internal stack (e.g. ARP requests, PING requests, HTTP requests). The number in (+nn) displays the number of packets transmitted since the last page refresh.

Packets From Internal Stack.This displays the total number of good packets the bridge has received from the internal stack (e.g. ARP responses, PING replies, HTTP responses). The number in (+nn) displays the number of packets received since the last page refresh.

Ethernet Runt Rx Packets .Total number of Runt (short) Ethernet packets received from the local Ethernet interface. On a half-duplex link, these packets are the result of collisions and are to be expected. If you have forced the Ethernet configuration to full-duplex and are getting runt packets then you probably have a duplex mismatch (the device you have connected to is running in half-duplex). The number in (+nn) displays the number of Runt packets received since the last page refresh.

L2 Source MAC Address Conflicts .The number of times a packet received over the wireless link had the Layer 2 (Ethernet) Source MAC Addresses of a device that had previously been transmitting on the 'local' Ethernet network. This could indicate the presence of a traffic loop or of L2 MAC Address spoofing on the network. The number in (+nn) displays the number of conflicts since the last page refresh

ARQ Retransmitted Rx Packets . Total number of ARQ retransmitted packets that have been received. The number in (+nn) displays the number of packets received since the last page refresh

PHY Code Word Error Counter The wireless link uses error correction techniques to enable reconstruction of packets where there is a certain level of data corruption. This counter displays the total number of packets that were so badly corrupted that they could not be reconstructed. The number in (+nn) displays the number of packets received since the last page refresh

Receive Data Rate The data rate in the receive direction, expressed in Mbps and presented as: max, mean, min, and latest histogram format.

The histogram is calculated over a one hour period. If the equipment has been running for less than one hour then the histogram is calculated over the current elapsed time.

Transmit Data Rate The data rate in the transmit direction, expressed in Mbps and presented as: max, mean, min, and latest histogram format.

The histogram is calculated over a one hour period. If the equipment has been running for less than one hour then the histogram is calculated over the current elapsed time.

Signal Strength Ratio The Signal Strength Ratio, is the ratio of the power received by the Vertical / Horizontal receivers.

Wireless Link Availability Expresses the link availability as a percentage of time since the first successful registration after a system restart. Expressed as a percentage to four decimal places.

Code Word Error Ratio The ratio of detected codeword errors to the total number of codewords since the last system reboot.

Statistics Page Refresh Period The statistics page refreshes automatically according to the setting entered here (in seconds).

Reset System Counters By pressing this button all counters in the system are reset to zero. This not only affects this page for example the Elapsed Time Indicator is also reset.

Reset System Histograms All histograms are reset, and the calculation period is restarted.

6.3.3 Install Pages

These pages are used during system installation. There follows a description of the install pages along with their use during the installation configuration process. The actual installation process is described in section 5.7.9 “Aligning the ODUs”.

All wireless links are shipped as paired units. They are pre-configured at the factory so that they can be installed without the user supplying any configuration. Each wireless link is shipped with a quick start guide. Attached to the quick start guide is a summary of the pre-configured configuration data.
Table 4 shows an example link configuration. The values highlighted have been committed to the wireless units non-volatile storage.

Example 45 Mbps Backhaul Configuration Data	
For your convenience these two units have been pre-configured as a link	
Units:	
ODU serial number	ODU serial number
0167800002BE	0167800002BF
Ethernet MAC address	Ethernet MAC address
00:04:56:00:02:BE	00:04:56:00:02:BF
Configured as:	
Master	Slave
Target MAC address	Target MAC address
00:04:56:00:02:BF	00:04:56:00:02:BE
License Key	License Key
A471-FE88-428D-E1F3	534F-4F54-D1B0-E2DA
IP Address	IP Address
169.254.1.2	169.254.1.1

Table 4 45 Mbps Backhaul Factory Configuration Values

The factory default configuration is written to the ‘semi-permanent’ configuration bank.

The factory default configuration is limited in range to 40 Km. If you wish to install a wireless link with a range of > 40 Km and < 200 Km you must follow the ‘Manually Configuring The Wireless Units’ in section 6.3.3.1.

The factory default configuration is set to Region 1. Region 1 allows the 45 Mbps Backhaul a maximum transmit power of 24 dBm. If the local 5.8 GHz regulatory regime limits the maximum transmit power (EIRP) to less than 24 dBm you should obtain a new license key from your local distributor or direct from Motorola. Alternatively in the short term, you should reduce the maximum transmit power by following the ‘Manually Configuring The Wireless Units’ in section 6.3.3.1.

6.3.3.1 Manually Configuring The Wireless Units

If the installer / system administrator wishes, they may modify the default installation configuration. If only the IP addresses are incorrect it is recommended that the values are changed via the configuration menu (Section 6.3.1). If any other parameters require modification then it is recommended that the system administrator use the Installation Wizard.

A detailed description of the Installation Wizard follows:

The 45 Mbps Backhaul operational software requires a license key to enable the wireless bridging capability and programs region code specific parameters in to the unit.

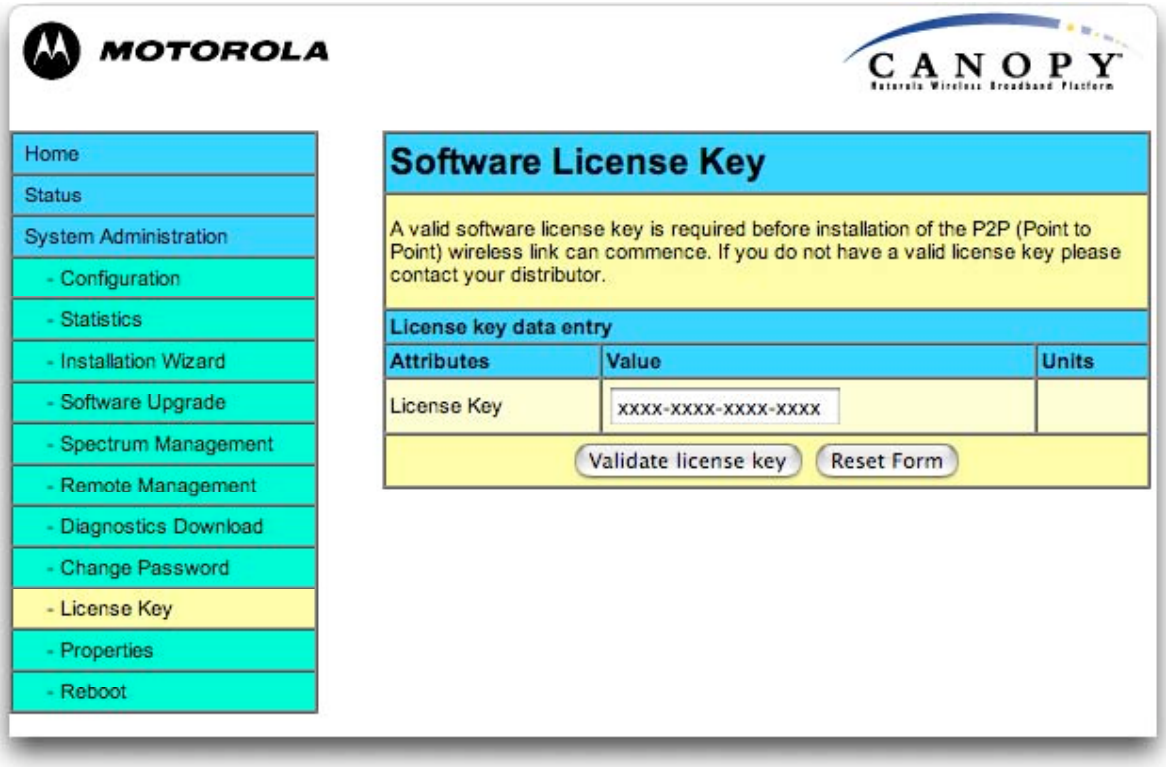


Figure 16 License Key Data Entry

A license key is programmed into each unit during production and can be found written on the Configuration Data Summary Label which is attached to the Quick Install Guide. If subsequently the license key has been mislaid, replacement keys can be applied for online.

If a valid license key is not detected in the unit's non-volatile memory then the user is prompted to enter a valid key. It should be noted that 45 Mbps Backhaul units are shipped as link pairs and as such valid license keys are entered during the production process. Hence the user should never see the Software License Key screen (Figure 16).

To enter a license key simply type or paste the license key into the data entry box and click the 'validate license key' button.

6.3.3.2 Internet Protocol Configuration

Step 1 of the installation wizard requires the installer to enter the Internet Protocol (IP) configuration.

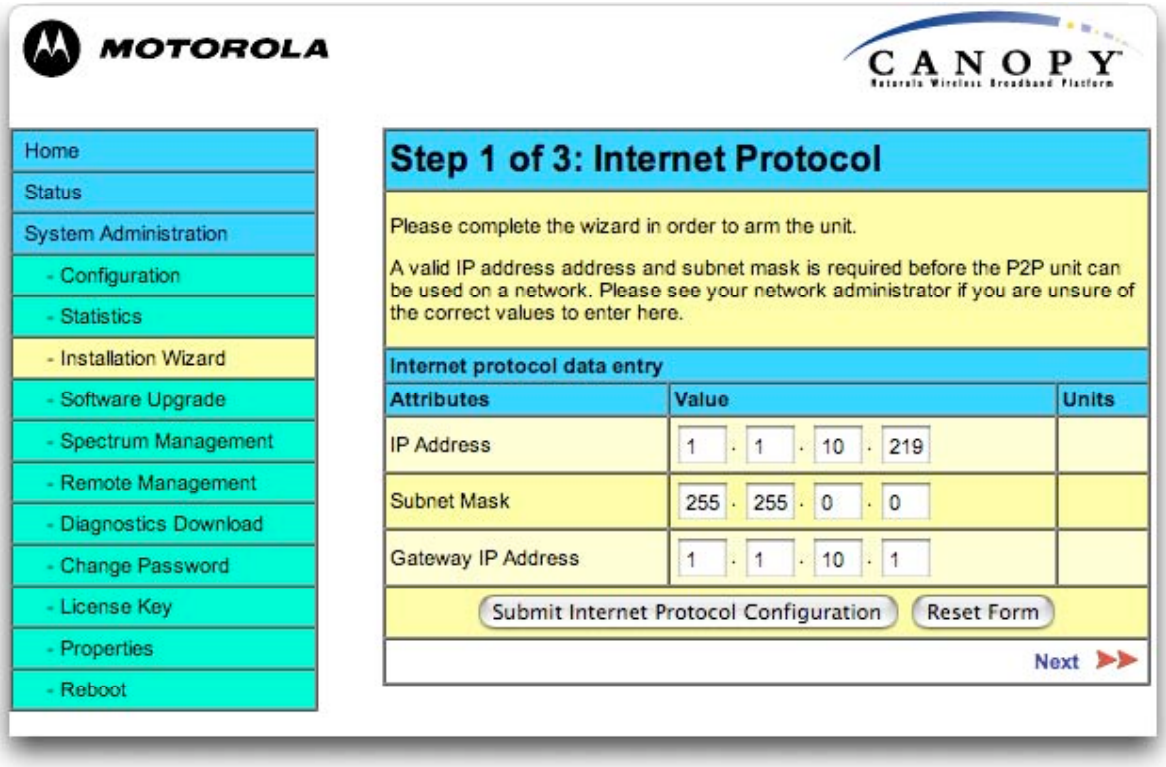

MOTOROLA
CANOPY
Home
Status
System Administration
- Configuration
- Statistics
- Installation Wizard
- Software Upgrade
- Spectrum Management
- Remote Management
- Diagnostics Download
- Change Password
- License Key
- Properties
- Reboot
Step 1 of 3: Internet Protocol
Please complete the wizard in order to arm the unit.
A valid IP address address and subnet mask is required before the P2P unit can be used on a network. Please see your network administrator if you are unsure of the correct values to enter here.
Internet protocol data entry
Attributes
Value
Units
IP Address
1 . 1 . 10 . 219
Subnet Mask
255 . 255 . 0 . 0
Gateway IP Address
1 . 1 . 10 . 1
Submit Internet Protocol Configuration
Reset Form
Next

Figure 17 Installation Wizard Internet Protocol Configuration.

Once complete click the ‘Submit Internet Protocol Configuration’ button or the ‘Next’ link.

6.3.3.3 Wireless Configuration

Step 2 of the installation wizard requires the installer to enter the wireless configuration parameters.

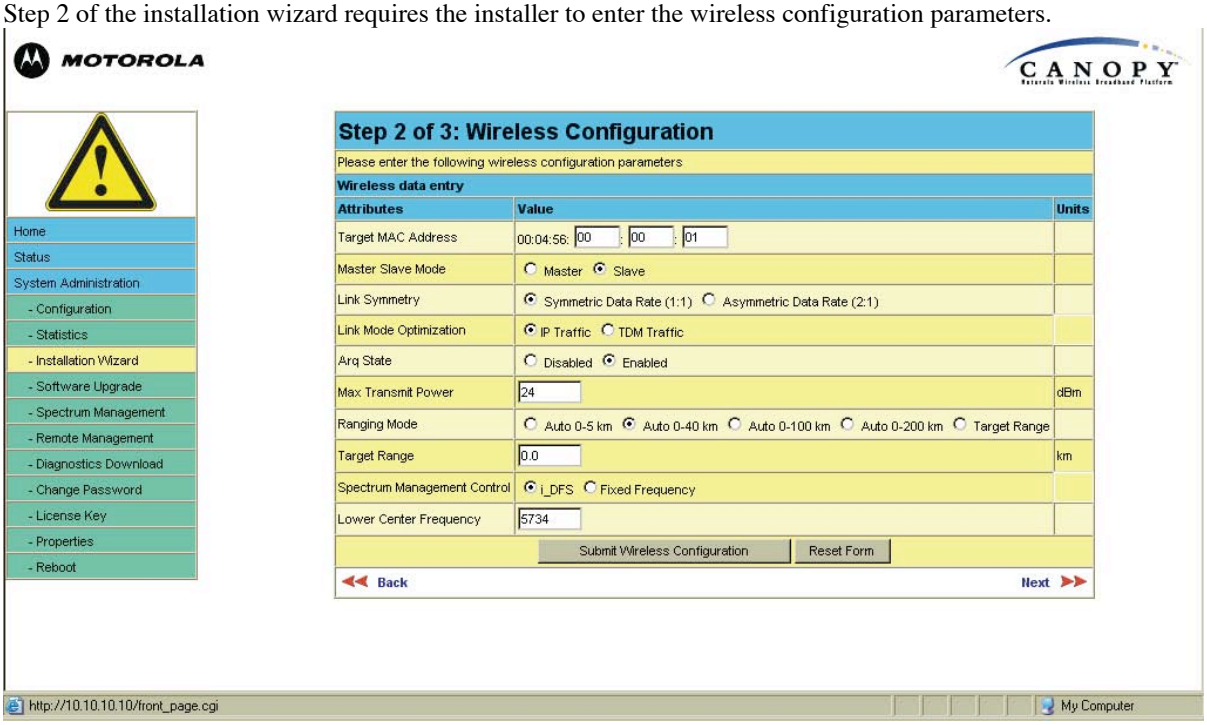


Figure 18 Installation Wizard Wireless Configuration

Target MAC Address The MAC Address of the peer unit that will be at the other end of the wireless link. This is used by the system to ensure the unit establishes a wireless link to the correct peer.

The MAC Address can be found embedded within the serial number of the unit. The last six characters of the serial number are the last three bytes of the unit's MAC address.

(Note: The 45 Mbps Backhaul system is shipped as a pair of units with pre-loaded correct MAC addresses. MAC addresses will only need to be entered if an existing unit has to be replaced in the field or the units configuration has been erased).

Master Slave Mode At this point it is necessary to decide which end will designated a Master. The Master unit is the controlling unit with respect to the Point-to-Point link and its maintenance. The master transmits until the link is made, while the Slave listens for its peer and only transmits when the peer has been identified.

Link Symmetry By default Link Symmetry of a Point-to-Point link is 'Symmetrical Data Rate (1:1)' in this configuration the ratio of time the wireless link spends transmitting and receiving is equal. When Link Symmetry is configured to Asymmetric Data Rate (2:1) the wireless link Master will spend twice as long transmitting as receiving. It should be noted that the data rate available to the end users might not follow these ratios exactly. The exact data rates will be dependant on the prevailing modulation. If the direction you want to install the link asymmetry not achievable in the current configuration then the master and slave modes of both 45 Mbps Backhaul units will need to be reversed.

ARQ State Automatic Repeat reQuest (ARQ) is a mechanism where packets lost due to transmission errors over the wireless link are retransmitted rapidly. The retransmission helps to prevent TCP congestion mechanisms from inadvertently interpreting intermittent pack loss as network congestion. ARQ must be enabled on both ends of the Point-to-Point link for it to function.

Max Transmit Power This attribute controls the maximum transmit power the unit is permitted to use when installing and executing the wireless link.

Ranging Mode During installation the wireless units perform automatic ranging. The ranging mode allows the installer to control the behavior of the systems automatic ranging algorithms. The default value is 0 to 40 km[7]. If the installer is required to install a link of greater than 40 km then the ranging mode attribute MUST be configured to 0 to 130 km mode. Likewise selecting the 0 to 5 km mode for links under 5 km will give you optimal performance. Installers that know the range between the two wireless units to within ± 1 km can use the target range mode. The main advantage of the target range mode is that it reduces the time taken by the units to range. To use the target range mode the installer MUST select the Target as the ranging mode and enter the approximate range in km in the Target range data entry field.

Once the installer is satisfied with the wireless configuration options then the 'Submit Wireless Configuration' button or the 'Next' link should be clicked.

Spectrum Management Control Is used to configure the 45 Mbps Backhaul Spectrum Management features, see section 6.3.5 for more details. i_DFS is the abbreviation for intelligent Dynamic Frequency Selection, this feature continually monitors the 5.8 GHz spectrum looking for a the channel with the lowest level of on channel and co-channel interference. Fixed frequency mode allows the installer to fix the transmit and receive frequencies on the units. The frequencies may be configured symmetrically or asymmetrically.

6.3.3.3.1 Lower Center Frequency

The 45 Mbps Backhaul software allows a user to optionally adjust the channel center frequencies. The default starting channel center frequency is 5734 MHz. This value can be adjusted to either 5732 or 5736 MHz.

Changing the Lower Center Frequency attribute causes all channel center frequency to be offset. It effectively slides the channelization up or down 2 MHz.

Warning: The lower center frequency attribute must be configured to the same value for of both the master and slave. Failure to do so will cause the wireless link to fail reestablishment. The only way to recover from this situation is to modify the Lower Center Frequency attribute so that they are identical on both the master and slave unit.

6.3.3.3.2 Fixed Transmit Frequency, Fixed Receive Frequency

The 45 Mbps Backhaul software allows a user to optionally fix transmit and receive frequencies for a wireless link. Once configured the spectrum management software will not attempt to move the wireless link to a channel with lower co and adjacent channel interference. Therefore this mode of operation is only recommended for deployments where the installer has a good understanding the prevailing 5.8 GHz interference environment. Figure 19 shows an example fixed frequency configuration. The lower center frequency is set to its default values and the Fixed Transmit Frequency is set to 5740 MHz and the Fixed Receive Frequency is set to 5782 MHz. Care must be taken when configuring the Fixed Transmit and Receive Frequencies to ensure that both frequencies are on the same 6 MHz channel raster as the Lower Center Frequency. For example both the Fixed Transmit and Receive Frequencies must be a multiple of 6 MHz from the Lower Center Frequency (5740 = 5734 + 6 MHz) and (5782 = 5734 + 6 MHz × 8).

[7] If preferred 45 Mbps Backhaul range functions can be configured to operate in miles, see the Properties page in section 6.3.12.

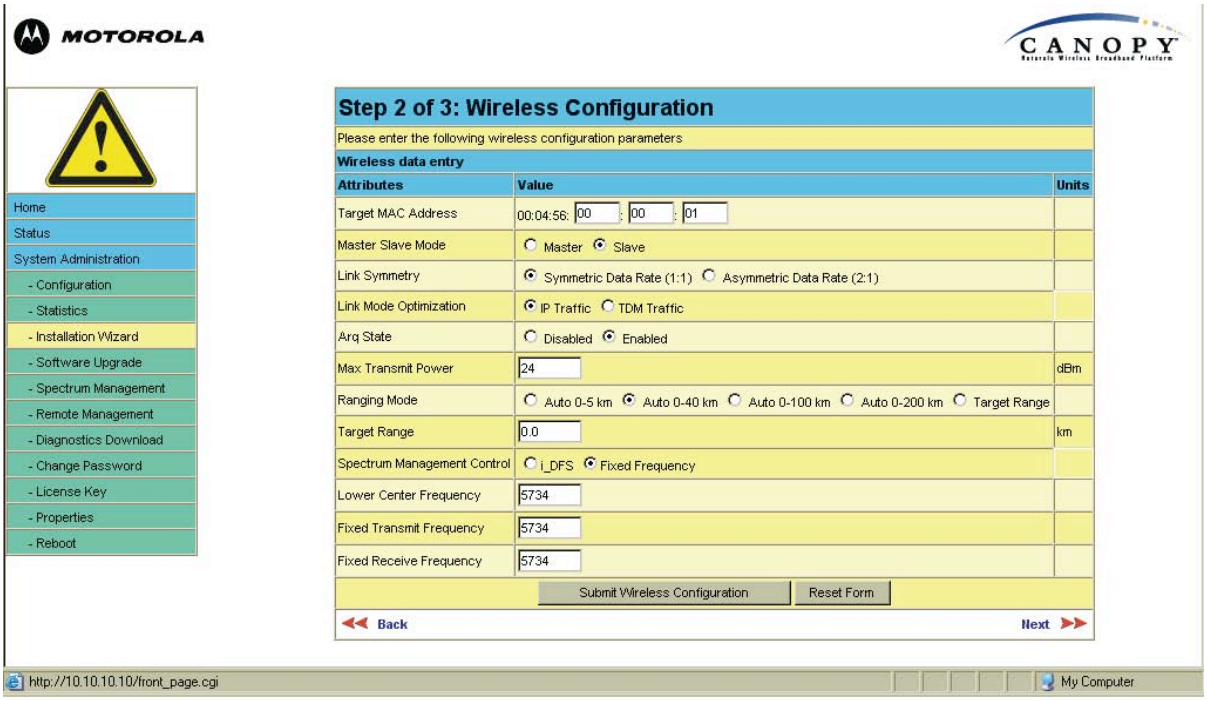


Figure 19: Fixed Frequency Operation

6.3.3.4 Confirm Configuration

Step 3 of the installation wizard allows the installer to review and confirm the installation information before committing the information to non-volatile memory (Figure 20)

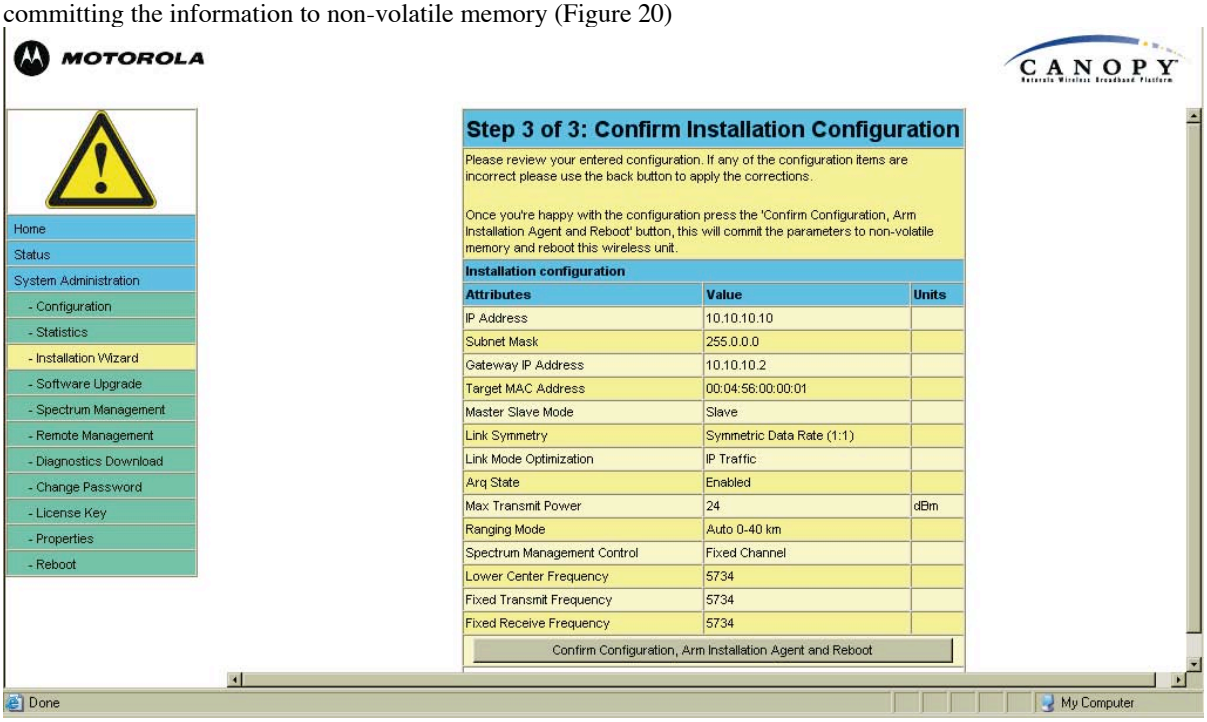

MOTOROLA
CANOPY
Home
Status
System Administration
- Configuration
- Statistics
- Installation Wizard
- Software Upgrade
- Spectrum Management
- Remote Management
- Diagnostics Download
- Change Password
- License Key
- Properties
- Reboot
Step 3 of 3: Confirm Installation Configuration
Please review your entered configuration. If any of the configuration items are incorrect please use the back button to apply the corrections.
Once you're happy with the configuration press the 'Confirm Configuration, Arm Installation Agent and Reboot' button, this will commit the parameters to non-volatile memory and reboot this wireless unit.
Installation configuration
Attributes | Value | Units
IP Address | 10.10.10.10
Subnet Mask | 255.0.0.0
Gateway IP Address | 10.10.10.2
Target MAC Address | 00:04:56:00:00:01
Master Slave Mode | Slave
Link Symmetry | Symmetric Data Rate (1:1)
Link Mode Optimization | IP Traffic
Arq State | Enabled
Max Transmit Power | 24 | dBm
Ranging Mode | Auto 0-40 km
Spectrum Management Control | Fixed Channel
Lower Center Frequency | 5734
Fixed Transmit Frequency | 5734
Fixed Receive Frequency | 5734
Confirm Configuration, Arm Installation Agent and Reboot
Done
My Computer

Figure 20 Installation Wizard Confirm Configuration.

If all the settings are correct and appropriate click the “Confirm Configuration and Reboot Unit” button. All the attributes are committed to non-volatile memory. Immediately following the write to non-volatile memory the unit is reset.

Note: If you have changed the Ethernet parameters you must reconnect using the correct network and address settings.

6.3.3.5 Disarm

Step 5 of the installation wizard is the disarm phase.

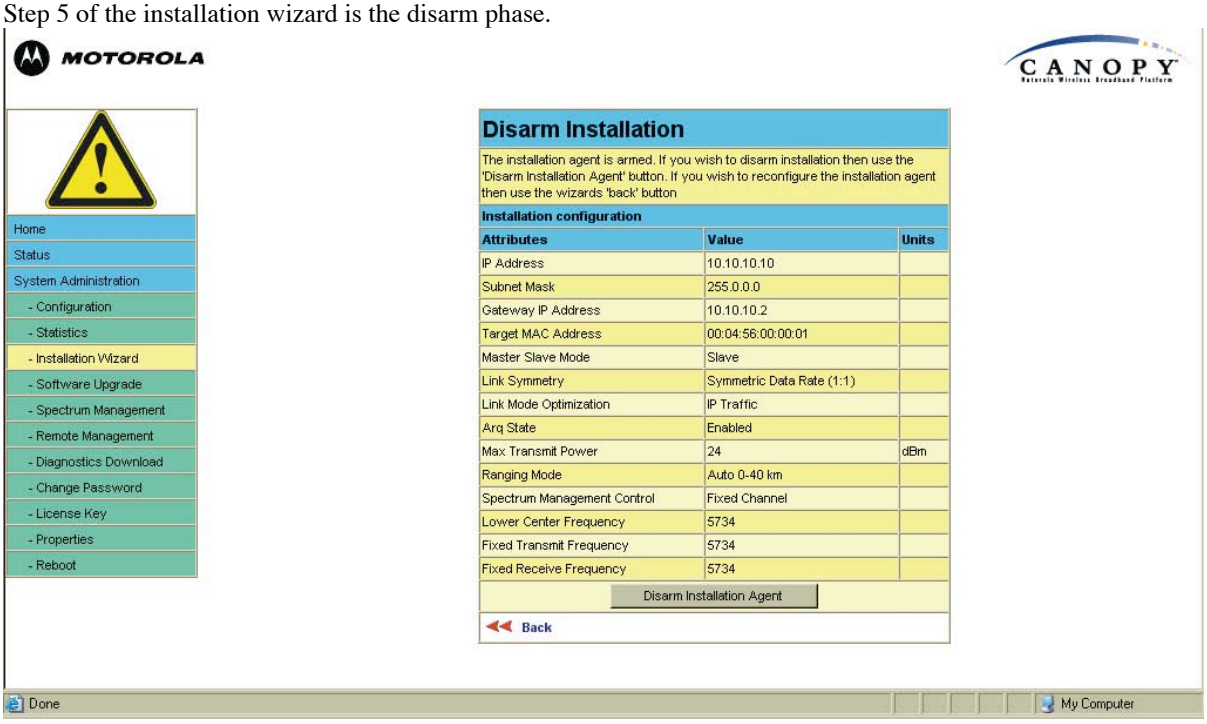


Figure 21 Disarm Installation.

Once section 5.7.9 “Aligning the ODUs” is complete pressing the “Disarm Installation Agent” button completes the installation process and the audible installation tone will be switched off. If the installer wishes to modify the installation configuration then the ‘Back’ link can be used to access the installation wizard steps described above.

After disarming the wireless link the use is presented with an optional configuration page see Figure 25. The screen presents hyper links to the main configuration and spectrum management pages.

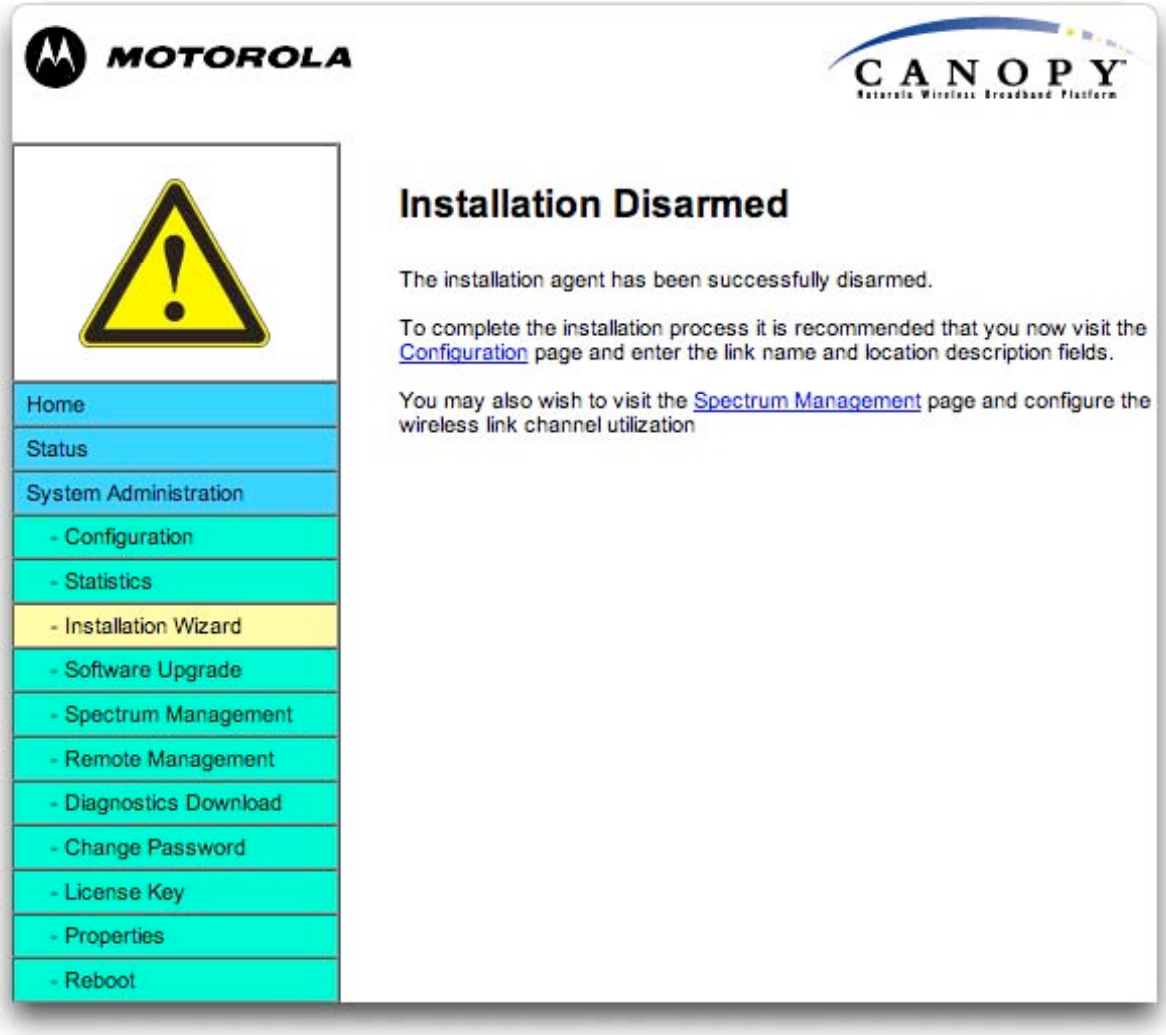

MOTOROLA
CANOPY
Installation Disarmed
The installation agent has been successfully disarmed.
To complete the installation process it is recommended that you now visit the Configuration page and enter the link name and location description fields.
You may also wish to visit the Spectrum Management page and configure the wireless link channel utilization
Home
Status
System Administration
- Configuration
- Statistics
- Installation Wizard
- Software Upgrade
- Spectrum Management
- Remote Management
- Diagnostics Download
- Change Password
- License Key
- Properties
- Reboot

Figure 22: Optional Post Disarm Configuration

6.3.4 Software Upgrade

The 45 Mbps Backhaul system has two software image banks; one is a fixed image which is stored in protected non-volatile memory and is not modifiable by the user, the second bank is used by the system administrator to upgrade the firmware as and when necessary. Figure 23 shows the main software upgrade webpage.

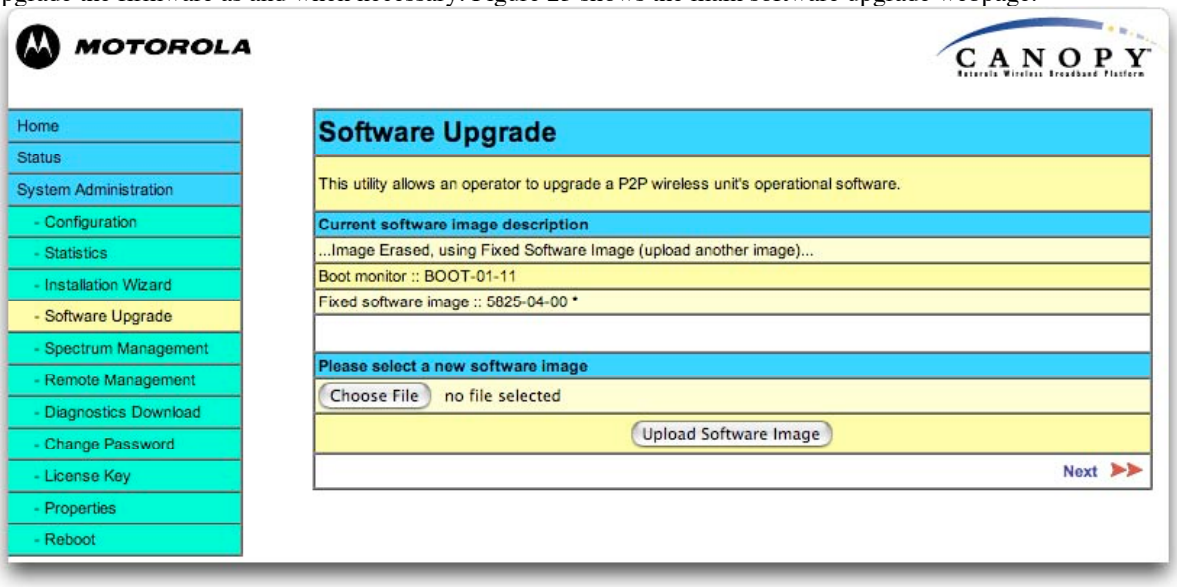


Figure 23 Software Upgrade

The 'Fixed' image is only used if disaster recovery is required, i.e. if an upgrade process is interrupted or the units are reset to their factory defaults.

These pages are used to update a unit's operational software. The software image to be uploaded should be downloaded to local storage from the Canopy website at http://www.motorola.com/canopy. The software image is delivered by Motorola as a compressed zip file. Once the zip file has been downloaded the user should extract the 45 Mbps Backhaul Software image, identifiable by its '.dld' file extension.

The first step (Figure 23) is to use the "Browse" button to locate the software image previously downloaded to local storage from the Canopy website. Once the image is located the user should press the "Upload image to wireless unit" button to start the software upgrade process.

The software image will now be uploaded to the unit where it will be stored in SDRAM until it is committed to the unit's non-volatile memory. This upload should only take a few seconds, once complete the image is verified and validated to ensure that no errors occurred during transfer and the image is valid to run on the current platform. If there are any problems a warning screen will appear.

The unit being upgraded will now display information about the build it currently has stored in the image bank and the one that's just been uploaded. If the image is not the right one the user has the option to go back and reload a new image. (See Figure 23)

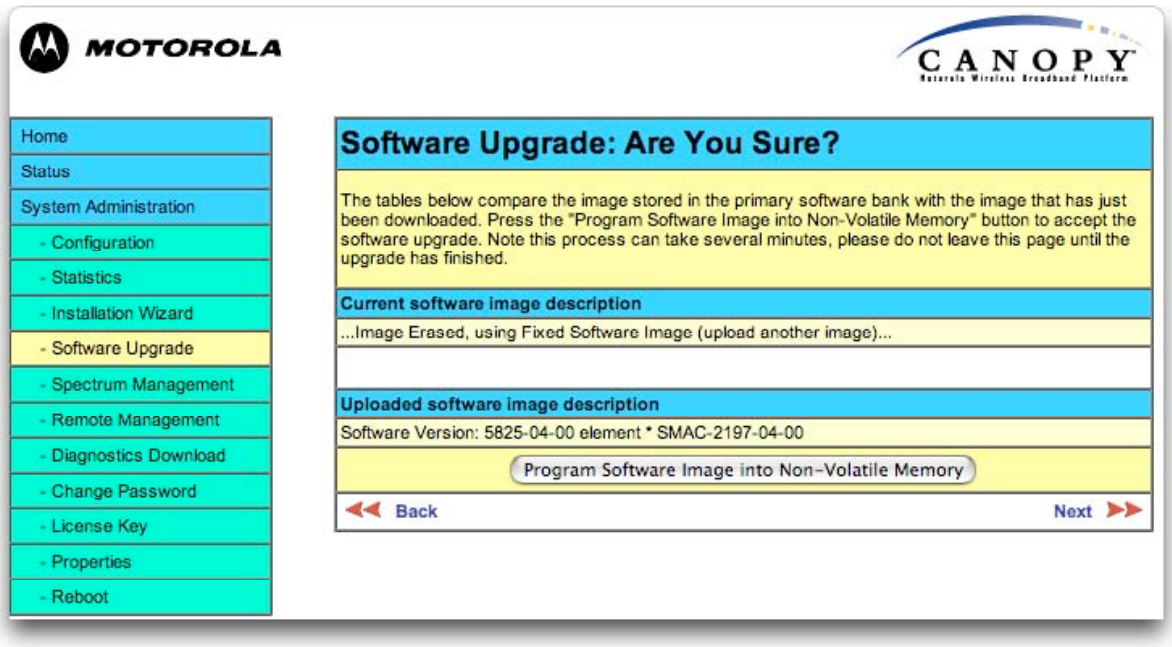

MOTOROLA
CANOPY
Home
Status
System Administration
- Configuration
- Statistics
- Installation Wizard
- Software Upgrade
- Spectrum Management
- Remote Management
- Diagnostics Download
- Change Password
- License Key
- Properties
- Reboot
Software Upgrade: Are You Sure?
The tables below compare the image stored in the primary software bank with the image that has just been downloaded. Press the "Program Software Image into Non-Volatile Memory" button to accept the software upgrade. Note this process can take several minutes, please do not leave this page until the upgrade has finished.
Current software image description
...Image Erased, using Fixed Software Image (upload another image)...
Uploaded software image description
Software Version: 5825-04-00 element * SMAC-2197-04-00
Program Software Image into Non-Volatile Memory
Back
Next

Figure 24 Software Upgrade Image Check

The user should ensure that the correct image is shown before pressing the “Program Software Image into Non-Volatile Memory” button. Once this button has been pressed the image is stored into non-volatile memory, this process can take up to 60 seconds and must not be interrupted.

If the upgrade process is interrupted during the erasure of the image bank or during the reprogramming of the image bank the image bank will be left in a corrupt state. If this occurs the software must be reloaded. All software images that are stored in FLASH memory are protected via the use of 32-bit CRCs. If the software detects a invalid CRC the image bank is marked as ‘corrupt’ and the 45 Mbps Backhaul boot code will boot the fixed software image. If this occur the user must attempt to reload the correct version of software.

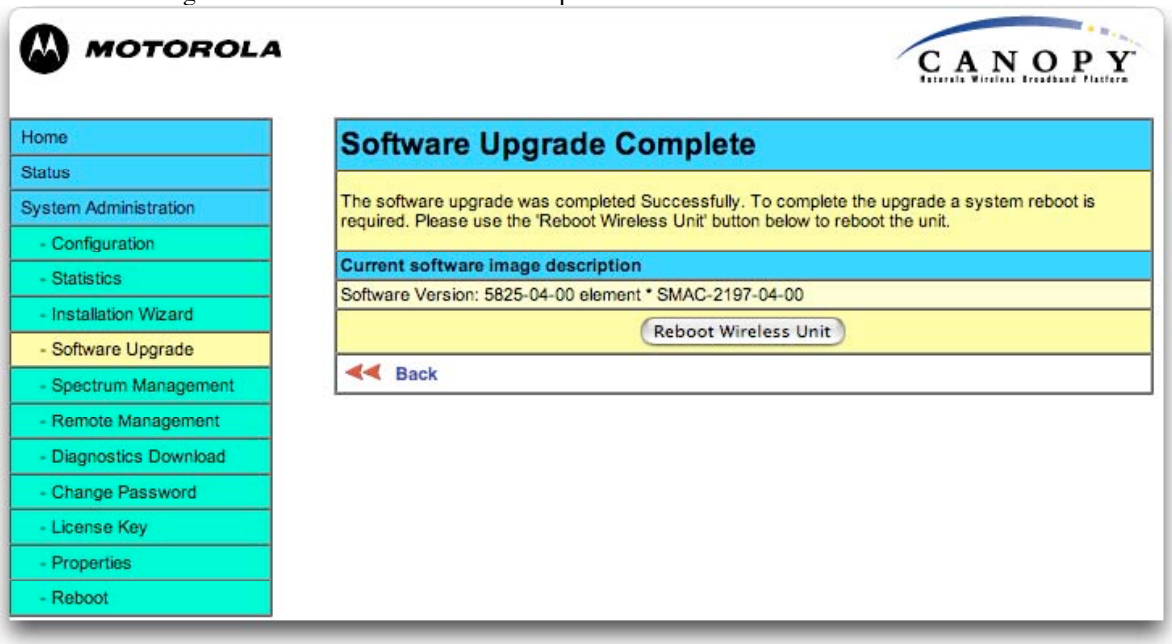


Figure 25 Software Upgrade Complete

When the software image has been written to non-volatile memory Figure 25 will be displayed showing the status of the software upload.

Reboot the unit by clicking the Reboot Unit button. This will reboot the unit within 30 seconds, during this time you will not be able to communicate with the unit. The unit is now fully functional.

If this screen is not displayed after 60 seconds this could indicate a problem with the memory update process.

The user should now power cycle the unit to start using the new software image. The unit's boot software will automatically determine the health of the newly uploaded software image. If any problems were encountered the boot code will revert to a protected fixed software image

After the power cycle the user should check that the required software image is loaded and running by re-entering the Upgrade page where the software bank status will be displayed.

6.3.5 Spectrum Management (Non UK)

Spectrum Management Selection (previously referred to by the acronym DFS) is the 45 Mbps Backhaul wireless feature that monitors the available wireless spectrum and directs both ends of the wireless link to operate on a channel with the minimum level of co and adjacent levels interference.

6.3.5.1 Wireless Channels

The 45 Mbps Backhaul wireless operates using a set of predefined overlapping channels. There are 19 predefined channels starting at 5734 MHz and ending at 5842 MHz. Each channel occupies 11 MHz of wireless spectrum and is offset in center frequency from its neighboring channel by 6 MHz.

It is important to note that adjacent channels on the Spectrum management display have a 5 MHz overlap to the adjacent channel.

The default channelization can be modified by varying lower center frequency attribute in the installation wizard see section 6.3.3.3.1 ‘Lower Center Frequency’.

6.3.5.2 Spectrum Management Measurements

The 45 Mbps Backhaul wireless units perform four Spectrum Management measurements per TDD cycle, per channel. The measurements are subdivided into two signal peak measurements and two mean signal measurements. The peak measurements represent the peak received signal power with a resolution down to 100 nS. The mean measurement represents the mean received signal power for the 40 µS measurement period.

The Spectrum Management algorithm collects measurements equally from all channels. This process is called the Channel Availability Check (hereafter referred to by the acronym CAC). The CAC uses a round-robin channel select process to collect an equal amount of measurements from each channel. It is important to note that the CAC measurement process is not altered by channel barring process. Measurements are still collected for all channels irrespective of the number of barred channels.

6.3.5.3 Measurement Analysis

Spectrum Management uses statistical analysis to process the received peak and mean measurement. The statistical analysis is based on a fixed measurement quantization period. Spectrum Management collects data for the specified quantization period and only at the end of the period is the statistical analysis performed. The analysis produces four key metrics for each channel:

- Peak of Peaks
- Peak of Means
- 99.9% Percentile of the Means
- Mean of Means

Peak of Peaks is the largest peak interference measurement encountered during the quantization period. This metric is useful for detecting large short duration spikes in the interference environment.

Peak of Means is the largest mean interference measurement encountered during the quantization period. The peak of means is similar to the peak of peaks and is useful for detecting slightly longer duration spikes in the interference environment.

99.9% Percentile of the Means is the value of mean interference measurement for which 99.9% of all mean measurements fall below during the quantization period. The 99.9% percentile metric is useful for detecting short duration repetitive interference that by its very nature has a minimal effect of the mean of means.

Mean of Means is the arithmetic mean[8] of the measured means during a quantization period. The mean of means is a coarse measure of signal interference and gives an indication of the average interference level measured during the quantization period. The metric is not very good and predicting intermittent interference and is included to show the spread between the mean of means, the 99.9% percentile and the peak of means.

Important Note. f DFS uses the 99.9% percentile as the prime interference measurement. All subsequent references to interference level refer to this percentile measurement.

The display of statistical measurement on the spectrum management page always shows a statistical summary of all channel measurement. The statistical summary is controlled by the Statistics Window attribute. This attribute defaults to a value of twenty minutes, which means that the mean and percentile values displayed for each channel are calculated over the 20 minute period. All channel decisions are made using the values computed over the statistics window period.

6.3.5.4 The Spectrum Management Master / Slave Relationship

By default Spectrum Management operates in a master / slave relationship. The master is assumed to be the link master configured during installation. All Spectrum Management configuration changes MUST be performed from the master, to enforce this the Spectrum Management webpage has a different appearance depending if you are viewing the data from the master or slave.

All configuration changes are applied at the master only. All configuration changes are messaged from the master to the slave. Any Spectrum Management configuration messages received at the slave are stored in non-volatile memory. This enables both master and slave to keep identical copies of Spectrum Management configuration data in their non-volatile memories. It is therefore possible to swap master and slave roles on an active Point-to-Point link without modifying Spectrum Management configuration.

Figure 26 shows an example Spectrum Management webpage as seen from the master. Figure 27 shows an example Spectrum Management webpage as seen from the slave. It should be noted that not all the key Spectrum Management configuration attributes are available on the slave webpage.

[8] The arithmetic mean is the true power mean and not the mean of the values expressed in dBm.

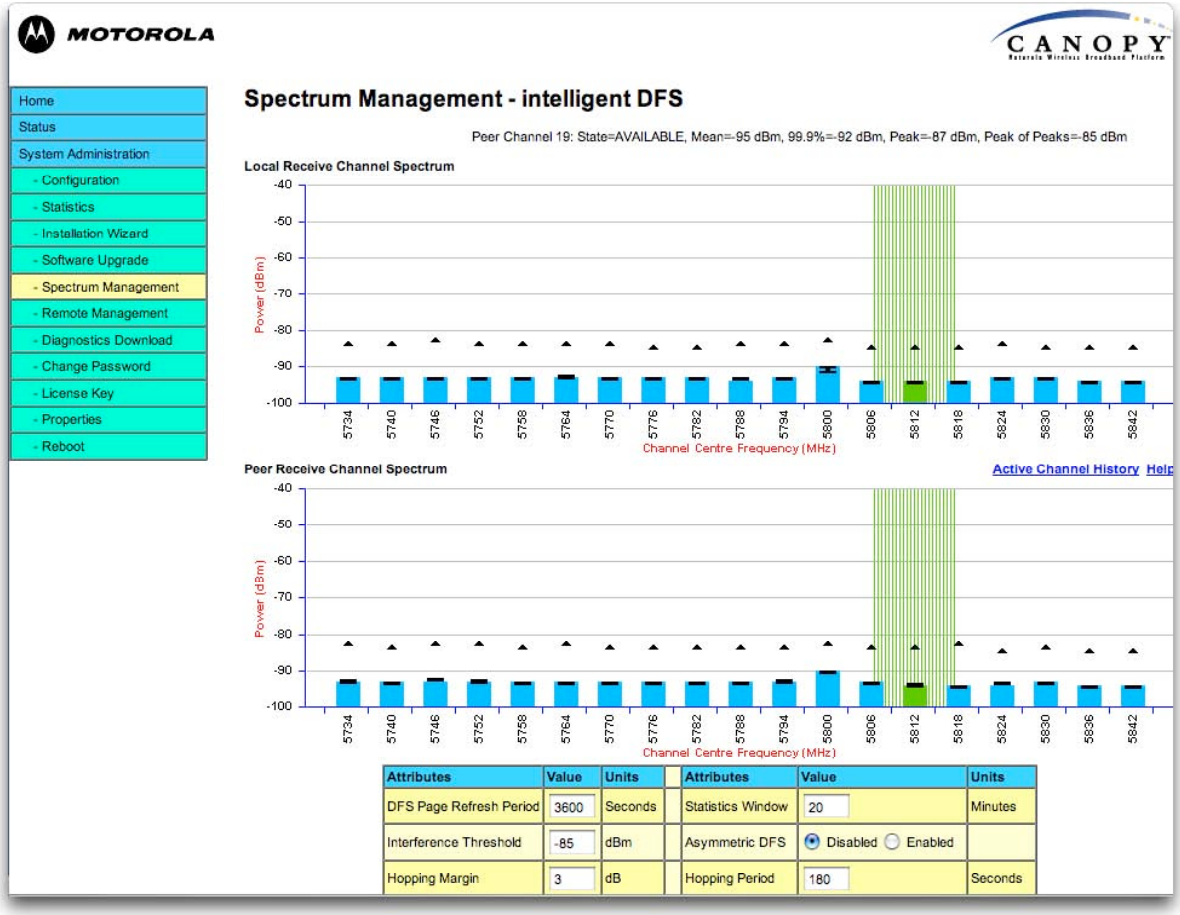


Figure 26 DFS as seen from the Master

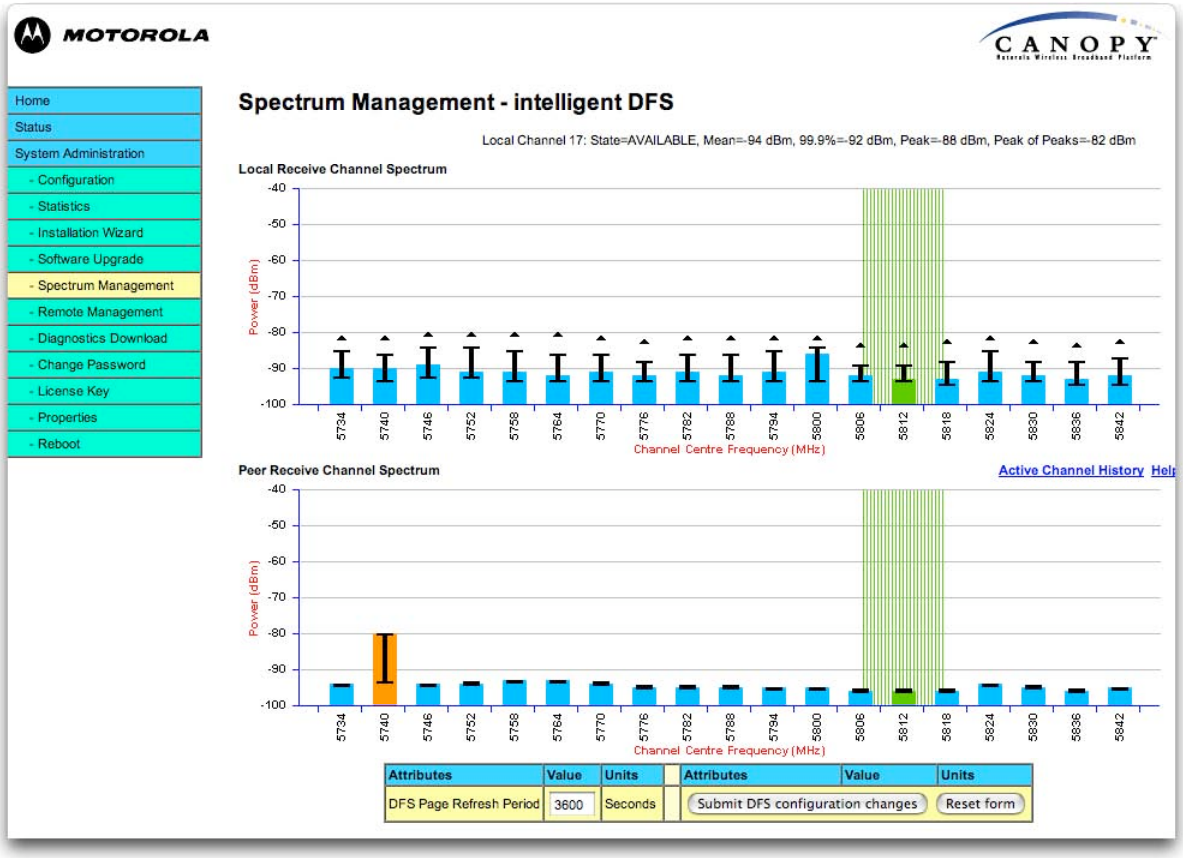


Figure 27 Spectrum Management as seen from the Slave

6.3.5.5 Spectrum Management Configuration

The following section describes the user modifiable configuration assessible from the DFS webpage. It is recommended that the default values are maintained. If the user believes that the performance of the DFS algorithm requires some modifications this should only be done after consulting your distributor or one of the Motorola field support engineers.

Refresh Page Period The DFS page refreshes automatically according to the setting entered here (in seconds).

Hopping Period The DFS algorithm evaluates the DFS metrics every 'Hopping Period' seconds (180 seconds by default) looking for a channel with lower levels of interference. If a better channel is located then DFS performs an automated channel hop. If SNMP and or SMTP alerts are enabled an SNMP TRAP and or an email alert is sent warning the system administrator of the channel change. (Default 180 Seconds).

Hopping Margin DFS uses this margin when making a channel hop decision. The channel to hop to has to have an interference level 3 dBs (default) better than the current active channel. (Default 3 dB)

Hopping Counter is used to record the number of channel hops. The number in the "(+)" brackets indicates the number of channel changes since the last screen refresh.

Asymmetric DFS. The default configuration of symmetric constrains DFS to operate symmetrically using the same transmit and receive channel. When in symmetric mode the slave unit will always follow the master. If the master moves to a new channel the slave will hop to the same channel. When the Point-to-Point link is configured as an asymmetric link both the master and slave a free to select the best channel from their own set of local interference metrics. (Default Symmetric).

Statistics Window. DFS uses statistical analysis to process the received peak and mean measurement. The statistical analysis is based around a fixed measurement quantization period. The default quantization period is one minute. DFS collects data for the specified quantization period and only at the end of that period is the statistical analysis performed. Increasing the measurement quantization period will reduce the dynamic response time of the algorithm but increase the statistical significance of the metrics. (Default 1 minute). Displaying and making decisions based on one minutes worth of data would make DFS very dynamic. Therefore the Statistics Window attribute allows the user to concatenate quantization periods before making the assessment of the prevailing interference environment. This allows the algorithms to bias away from any channel that has detected interference during the period of the statistics window and slow the channel hopping dynamics down. It also has the effect of biasing away from localized impulsive interference sources.

Interference Threshold. DFS uses the interference threshold to perform instantaneous channel hops. If the measured interference on a channel exceeds the specified threshold then DFS will instruct wireless immediately search for a better channel. If a better channel cannot be found then 45 Mbps Backhaul will continue to use the current active channel. (Default –85 dBm)

6.3.5.6 Barring Channels

Channels can only be barred / unbarred by the system administrator from the master DFS webpage. The barring / unbarring operations are disabled on the slave webpage. If an attempt to bar / unbar a channel is made at the slave a warning dialog is generated.

Barring / Unbarring of channels is performed by clicking the appropriate channel on the local or peer channel spectrum plots on the master webpage. Each bar / unbar attempt will be proceeded by a conformation dialog. It should be noted that the channel bar will take effect immediately and is not related to the measurement quantization period.

6.3.5.7 Local and Peer Channel Spectrum Graphics

Spectrum Management presents its computed statistical measurements in a graphical display on both the master and slave DFS webpage.

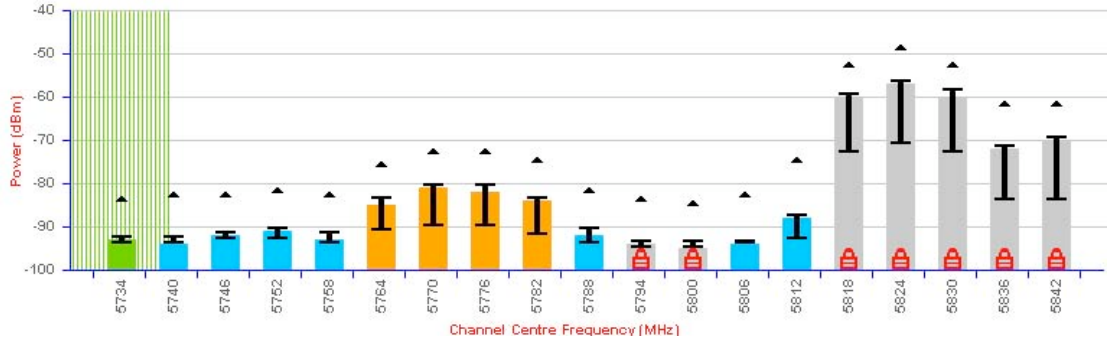


Figure 28 Example Spectrum Management Graphic

The X-axis shows a stylized view of the 19 selectable wireless channels. It is important to note that adjacent channels on the display have a 5 MHz overlap. The display separates the display of channels to help the clarity of the resultant display. The axis is labeled using the channel center frequencies in MHz.

The Y-axis shows the interference power levels from –100 to –40 dBm.

The active channel (channel 1 in Figure 28) is always marked using hatched green and white lines. The width of the hatching is directly proportional the 11 MHz spectral occupancy of the channel.

The individual channel metrics are displayed using a colored bar, an ‘I’ bar and a peak symbol.

The colored bar represents the following channel state:

Green	Active	The channel is currently in use hosting the Point-to-Point wireless link
Orange	Interference	The channel has interference above the interference threshold
Blue	Available	The channel has an interference level below the interference threshold and is considered by the Spectrum Management algorithm suitable for hosting the Point-to-Point link
Grey	Barred	The system administrator has barred this channel from use. Because the low signal levels encountered when a unit is powered up in a laboratory environment prior to installation (which makes the grey of the channel bar difficult to see). An additional red 'lock' symbol is used to indicate that a channel is barred.

Table 5 Spectrum Management (Non UK) change state key

The top of the colored bar represents the 99.9% percentile metric for specific channel.

The 'I' Bar is used to display the mean of means and peak of means metrics. The lower horizontal bar represents the mean of means and the upper horizontal bar represents the peak of means. The vertical bar is used as a visual cue to highlight the statistical spread between the peak and the mean of the statistical distribution.

The peak symbol (the upper small triangle above each channel 'I' bar) is used to indicate the peak of peaks interference measurement.

6.3.5.8 Active Channel History

The active channel history is a timeseries display of the channels used by the 45 Mbps Backhaul over the last 25 hours. The active channel history is activated from the main Spectrum Management page using the 'Active Channel History' hyperlink. An example of the active channel history display is shown in **Error! Reference source not found.**. Where there are parallel entries on the display this signifies that the wireless link occupied this channel during the measurement period. The measurement periods are one minute form zero to sixty minutes and twenty minutes from 60 minutes to twenty five hours.

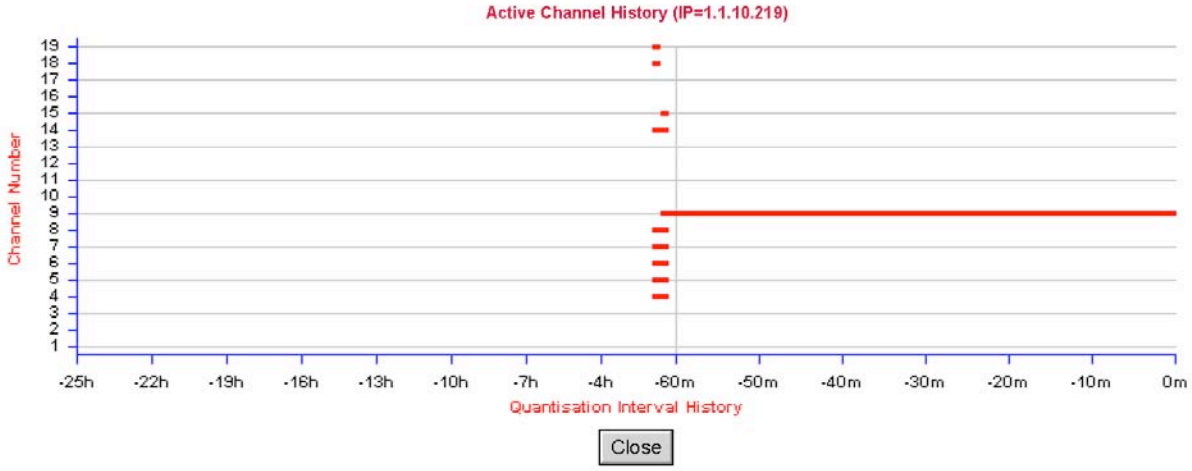


Figure 29: Active Channel History Screen

6.3.5.9 Viewing Historic Spectrum Management Metrics

Spectrum Management allows the system administrator to view the results of previous measurement quantization periods. Holding down the shift key and clicking the appropriate channel on the local channel spectrum plots activates this feature. This feature is available on both the master and slave webpage.

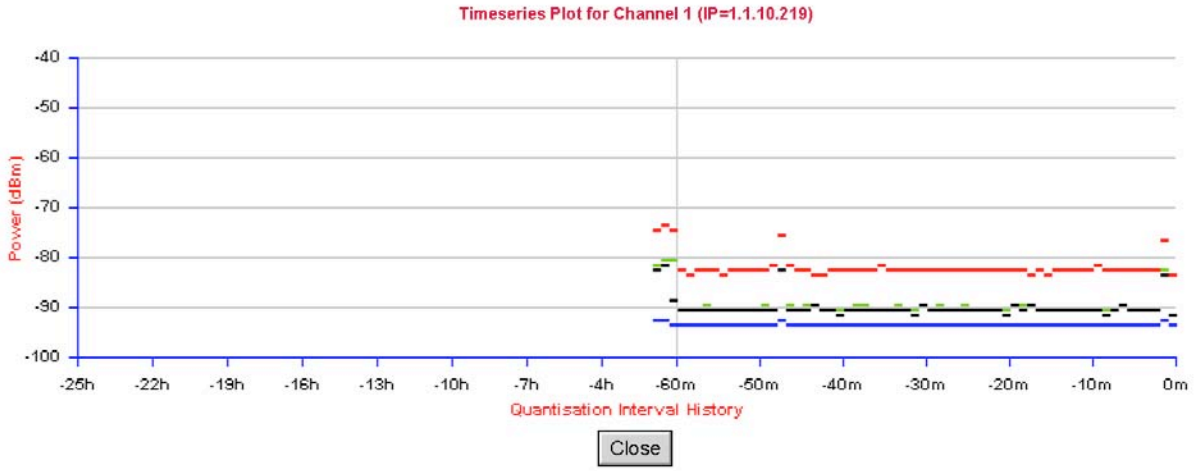


Figure 30 Spectrum Management Timeseries Plot

Figure 30 shows an example time series plot. A timeseries plot displays the previous 145 measurement quantization periods. If the 45 Mbps Backhaul unit has not been running for 145 quantization periods then only the number of measurement quantization periods that are available are displayed.

RED	Peak of Peaks interference measurement
GREEN	Peak of Means interference measurement
BLACK	99.9% percentile of means interference measurement
BLUE	Mean of Means interference measurement

Table 6 DFS timeseries key

6.3.5.10 SPECTRUM MANAGEMENT Online Help

Because the SPECTRUM MANAGEMENT displays contain a large amount of data, symbols and color references, an online help screen has been provided. This screen is accessible from both the master and slave webpages.

Figure 31 gives a high level overview of the DFS webpage.

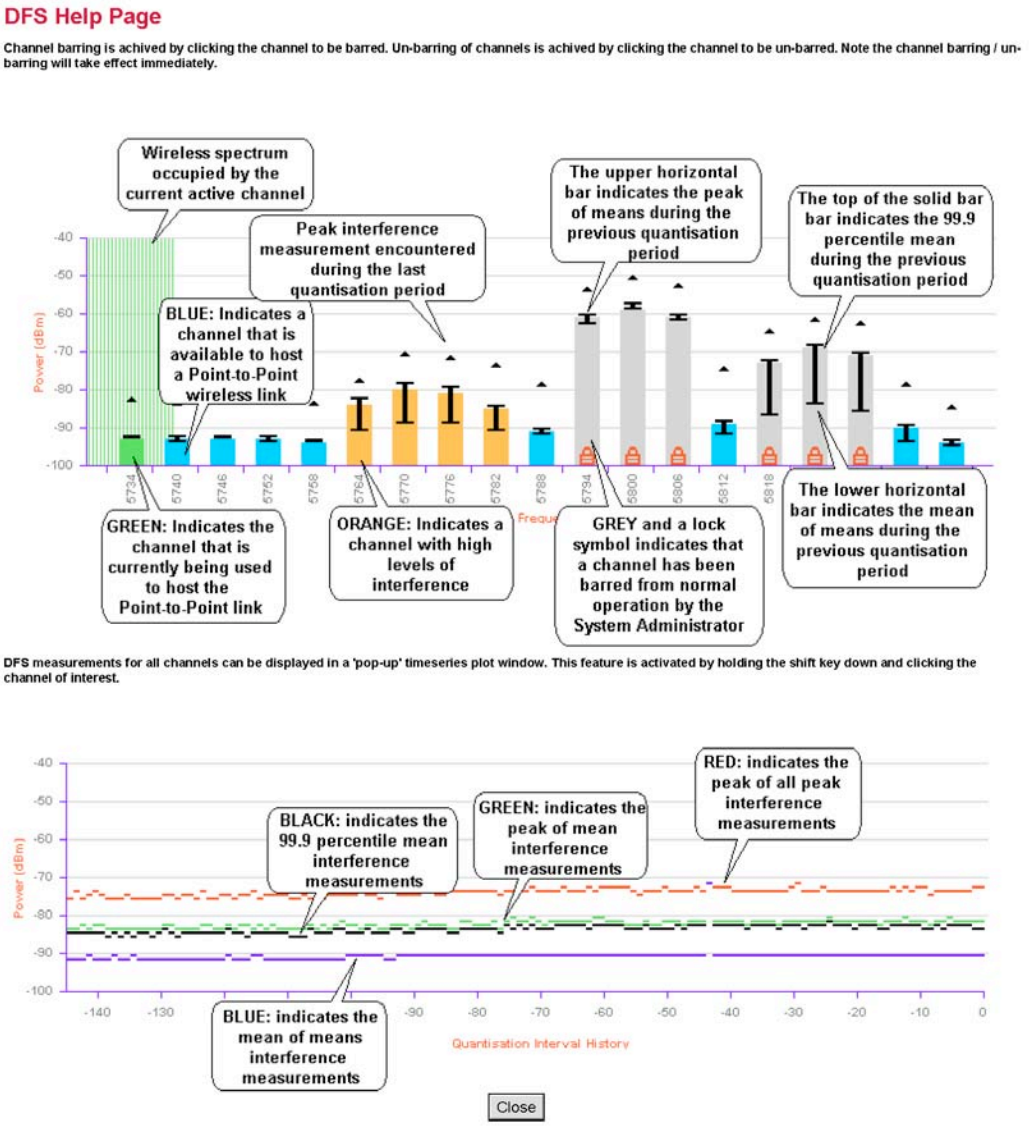

DFS Help Page
Channel barring is achived by clicking the channel to be barred. Un-barring of channels is achived by clicking the channel to be un-barred. Note the channel barring / un-barring will take effect immediately.
Wireless spectrum occupied by the current active channel
Peak interference measurement encountered during the last quantisation period
The upper horizontal bar indicates the peak of means during the previous quantisation period
The top of the solid bar bar indicates the 99.9 percentile mean during the previous quantisation period
BLUE: Indicates a channel that is available to host a Point-to-Point wireless link
GREEN: Indicates the channel that is currently being used to host the Point-to-Point link
ORANGE: Indicates a channel with high levels of interference
GREY and a lock symbol indicates that a channel has been barred from normal operation by the System Administrator
The lower horizontal bar indicates the mean of means during the previous quantisation period
DFS measurements for all channels can be displayed in a 'pop-up' timeseries plot window. This feature is activated by holding the shift key down and clicking the channel of interest.
RED: indicates the peak of all peak interference measurements
GREEN: indicates the peak of mean interference measurements
BLACK: indicates the 99.9 percentile mean interference measurements
BLUE: indicates the mean of means interference measurements
Power (dBm)
Quantisation Interval History
Close

Figure 31 SPECTRUM MANAGEMENT Help Page

6.3.6 Fixed Frequency

The 45 Mbps Backhaul software allows a user to optionally fix transmit and receive frequencies for a wireless link. Any frequency combination is allowed. Once configured the spectrum management software will not attempt to move the wireless link to channel with lower co and adjacent channel interference. Therefore this

mode of operation is only recommended for deployments where the installer has a good understanding the prevailing 5.8 GHz interference environment. Figure 19 shows an example fixed frequency configuration. The lower center frequency is set to its default value and the Fixed Transmit Frequency is set to 5740 MHz and the Fixed Receive Frequency is set to 5782 MHz. Care must be taken when configuring the Fixed Transmit and Receive Frequencies to ensure that both frequencies are on the same 6 MHz channel raster as the Lower Center Frequency. For example both the Fixed Transmit and Receive Frequencies must be a multiple of 6 MHz from the Lower Center Frequency (5740 = 5734 + 6 MHz) and (5782 = 5734 + 6 MHz × 8). To help the user when identifying the mode of operation Spectrum management uses two visual cues. See Figure 32. The main page title identifies the mode of operation using the '- Fixed Frequency Mode' postfix., and the selected channels are identified by a red capital 'F'.

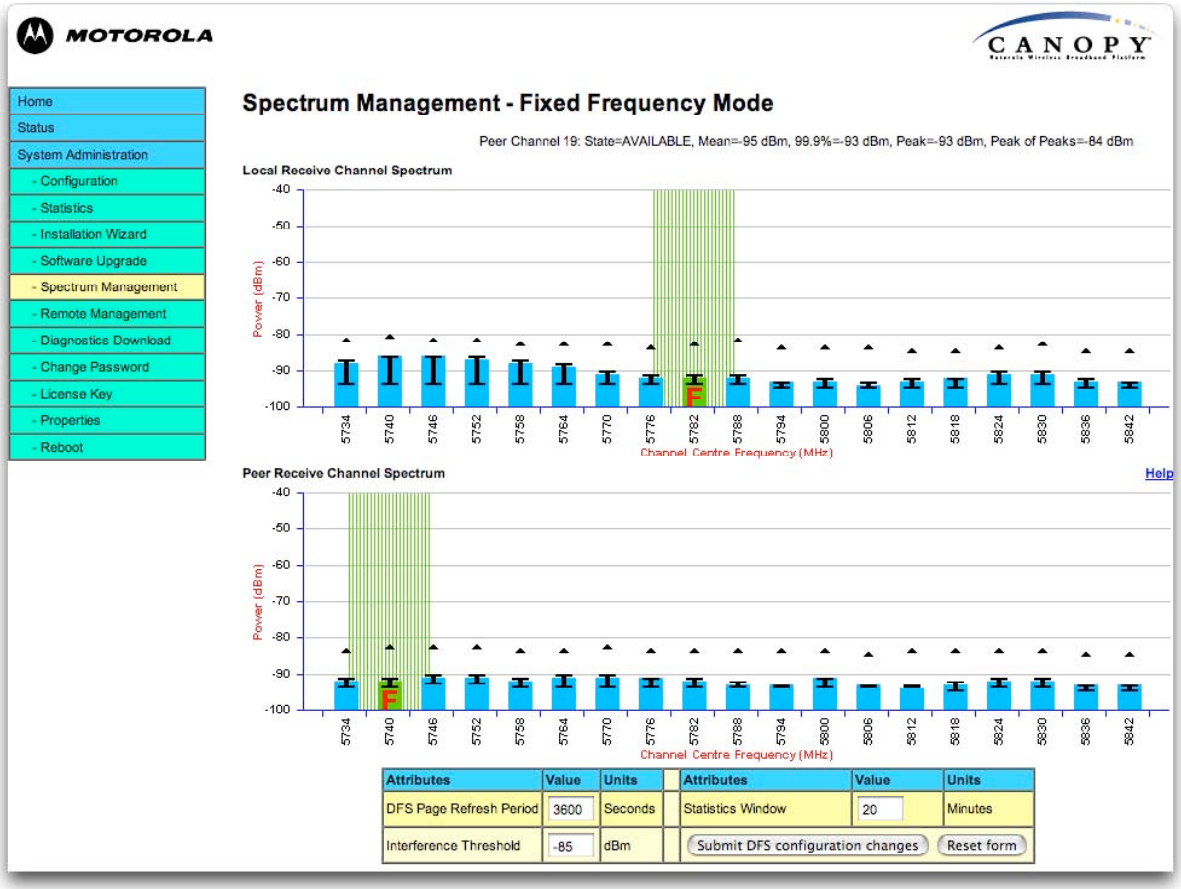


Figure 32: Spectrum Management Fixed Frequency Screen

Channel barring is disabled in fixed frequency mode as it is not required as dynamic channel hopping is prohibited in this mode.

The only controls available to the master are the Statistics Window and Interference Threshold attributes. They will have no effect of the operation of the wireless link and will only effect the generation of the channel spectrum graphics.

The active channel history menu is removed in this mode of operation as channel hopping is prohibited.

6.3.7 Spectrum Management (UK - Region 4)

To comply with the UK radar avoidance and Road Traffic Tolling (RTT) regulations. Spectrum Management when the 45 Mbps Backhaul is configured in region 4 has specific behavioral traits. These behavioral traits can

have a very large impact on the operation of the wireless link so it is important that the user understands how the UK regulations effect the wireless link when impulsive radar interference is detected.

The UK DFS requirements are specified in ETSI EN 301 893.

Their primary aims are:

Detect interference from other systems and to avoid co-channel operation with these systems, notably radar systems;

Provide on aggregate a uniform loading of the spectrum across all devices.

Prevent transmission in the RTT (Road Traffic Tolling) part of the spectrum 5794 to 5818 MHz.

6.3.7.1 Radar Detection

To address the primary aims the DFS algorithm implements a radar detection function which looks for impulsive interference on the active channel only. If impulsive interference is detect DFS will mark the current active channel as having detected a radar and initiate a channel hop to an available channel. The previous active channel will remain in the radar detected state for thirty minutes after the last impulsive interference pulse was detected. After the thirty minutes have expired the channel will be returned to the available channel pool.

The radar detection algorithm will always scan the active channel for 60 seconds for and radar interference before using the channel. This compulsory channel scan will mean that there is a 60 seconds service outage every time a radar is detected. This scan is mandated by the UK regulator.

6.3.7.2 Aggregate Uniform Loading

To address the “provide aggregate uniform loading of the spectrum across all devices” requirement, the channel selection algorithm will choose a channel at random from a list of available channels. The channel selection algorithm is initiated at link initialization and when radar interference is detected.

6.3.7.3 UK DFS Control

The only controls available to the master are the Statistics Window and Interference Threshold attributes. They will have no effect of the operation of the wireless link and will only affect the generation of the channel spectrum graphics.

A channel marked with a no entry symbol with their associated statistics colored black are the RTT prohibited channels. These channels are never used to host the wireless link, but CAC measurements are still taken so that adjacent channel biases can be calculated correctly and so the user can see if RTT equipment is in use.

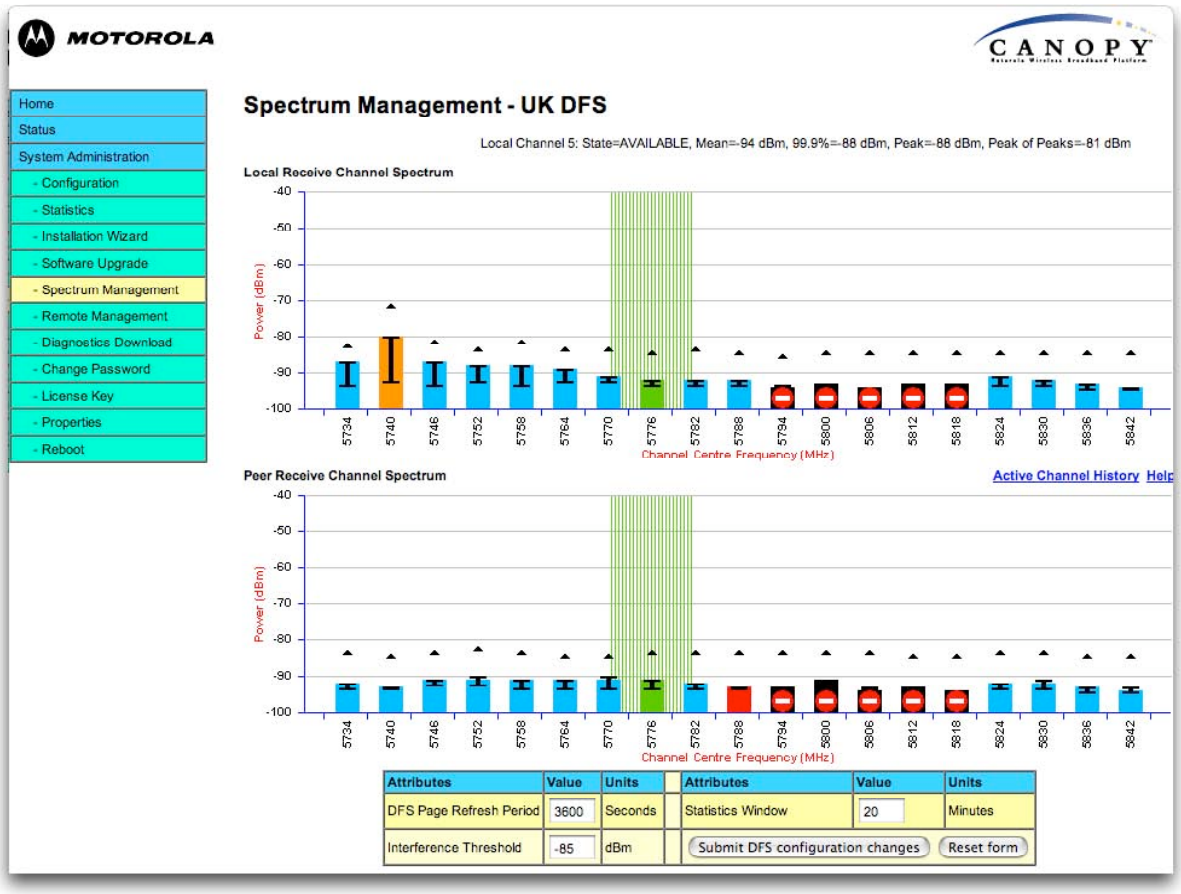


Figure 33: UK DFS Master Screen

The colored bar represents the following channel state:

Green	Active	The channel is currently in use hosting the Point-to-Point wireless link
Orange	Interference	The channel has interference above the interference threshold
Blue	Available	The channel has an interference level below the interference threshold and is considered by the DFS algorithm suitable for hosting the Point-to-Point link
Grey	Barred	The system administrator has barred this channel from use. Because the low signal levels encountered when a unit is powered up in a laboratory environment prior to installation (which makes the grey of the channel bar difficult to see). An additional red 'lock' symbol is used to indicate that a channel is barred.
Red	Radar Detected	Impulsive Radar Interference has been detected on this channel.
Region Bar	Region Bar	This channel has been barred from use by the local region regulator

Table 7 DFS change state key

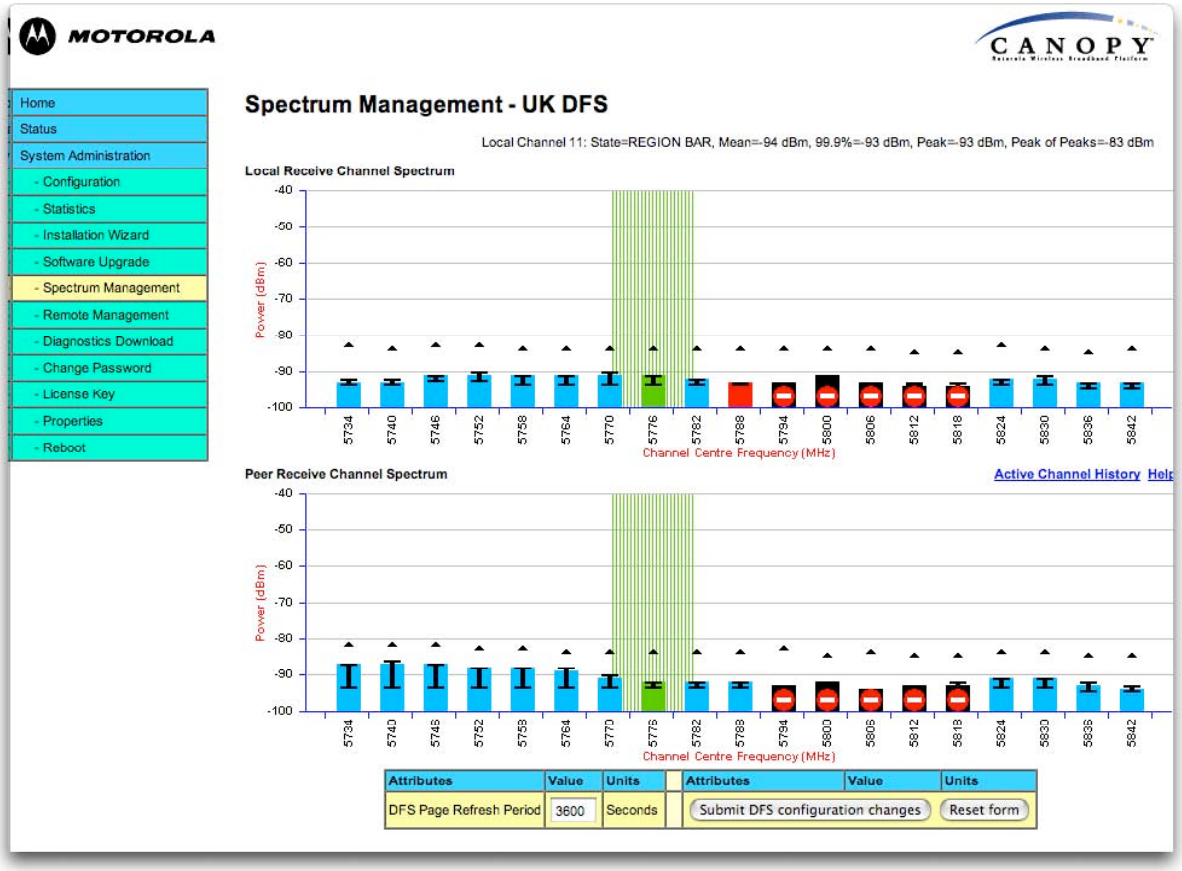


Figure 34: UK DFS Slave Screen

6.3.8 Remote Management Page

The Remote Management page (Figure 35) allows the system administrator to configure the remote management of the 45 Mbps Backhaul.

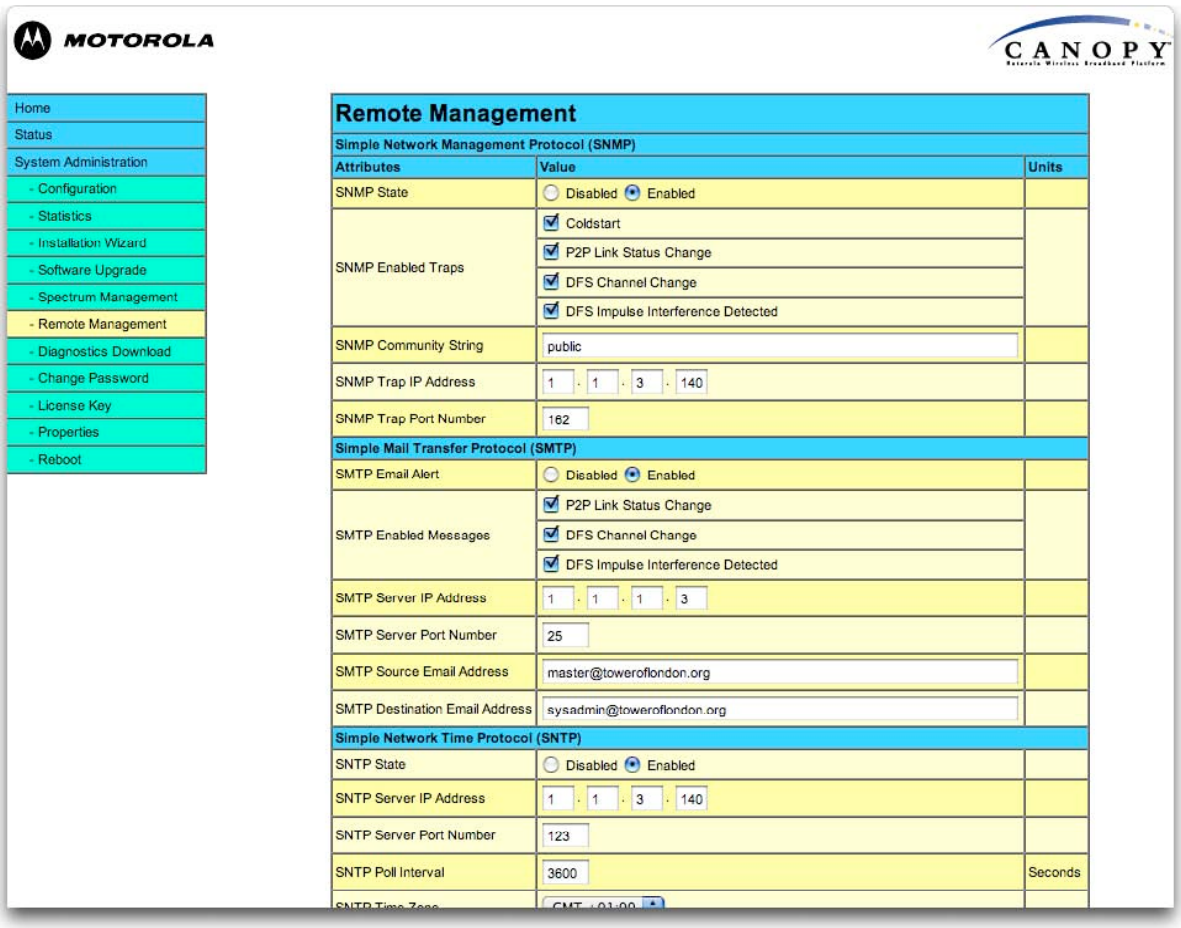


Figure 35 Remote Management

6.3.8.1 SNMP (Simple Network Management Protocol)

The industry standard remote management technique is SNMP (Simple Network Management Protocol). The 45 Mbps Backhaul supports version 1 and version 2 of the SNMP protocol.

6.3.8.1.1 Supported Management Information Bases (MIBS)

The industry standard remote management technique is SNMP (Simple Network Management Protocol). The 45 Mbps Backhaul supports SNMP version 1 and version 2.

The 45 Mbps Backhaul SNMP stack currently supports three distinct MIBs.

MIB-II, RFC-1213

The 45 Mbps Backhaul supports the ‘System Group’ and ‘Interfaces Group’.

Bridge MIB, RFC-1493

The 45 Mbps Backhaul supports the ‘dot1dBase Group’ and the ‘dot1dBasePortTable Group’.

SNMP TRAPs

‘Cold Start, ‘Link Up’, 'Link Down’, DFS Channel Change, DFS Impulsive Interference TRAPs are supported.

Motorola MIB, Proprietary MIB definition

For a copy of the Motorola proprietary MIB RFC please visit the Motorola website.

6.3.8.1.2 SNMP Configuration

SNMP State The SNMP state attribute controls the creation of the SNMP features. Changing the SNMP state attribute requires a mandatory reboot of the unit. Only when the SNMP state is enabled at system start-up will the SNMP processor task be created.

SNMP Enabled Traps The SNMP Enabled Traps attribute controls which SNMP Traps the unit will send.

SNMP Community String The SNMP community string acts like a password between the networks SNMP management entity and the distributed SNMP clients (45 Mbps Backhaul units). Only if the community string is configured correctly on all SNMP entities can the flow of management information take place. By convention the default value is set to ‘public’. When the community string is changed the system requires a mandatory reboot before the new string or phrase is adopted.

SNMP Trap IP Address Is the address of either the network SNMP manager or Trap receiver. When asynchronous events (Traps in SNMP terminology) are generated the client unicasts these to this IP Address. When the address is changed the system requires a mandatory reboot before the setting is adopted

SNMP Trap Port Number The SNMP Trap Port Number is the port number of either the networked SNMP manager or Trap receiver. By convention the default value for the port number is 162. When the port number is changed the system requires a mandatory reboot before the setting is adopted.

6.3.8.2 SMTP (Simple Mail Transport Protocol)

The SMTP client is an alternative method for the 45 Mbps Backhaul to alert the outside world when there are or have been system errors

SMTP Email Alert This attribute controls the activation of the SMTP client.

SMTP Enabled Messages The SMTP Enabled Messages attribute controls which email alerts the unit will send.

SMTP IP Address The IP address of the networked SMTP server.

SMTP Port Number The SMTP Port Number is the port number used by the networked SMTP server. By convention the default value for the port number is 25.

SMTP Source Email Address The email address used by the 45 Mbps Backhaul to log into the SMTP server with. This must be a valid email address that will be accepted by your SMTP Server

SMTP Destination Email Address The email address to which the 45 Mbps Backhaul will send the alert messages.

6.3.8.3 SNTP (Simple Network Time Protocol)

The SNTP client allows the 45 Mbps Backhaul to obtain accurate date and time updates from a networked timeserver. The resultant time information is used by the SNMP, webpage and System Reboot tasks.

SNTP State The SNTP state attribute controls the creation of the SNTP features.

SNTP IP Address The IP address of the networked SNTP server.

SNTP Port Number The port number of the networked SNTP server. By convention the default value for the port number is 123.

SNTP Poll Interval The period at which the SNTP client polls the server for time correction updates. Default 1 hour. If for any reason an SNTP poll fails the client will automatically perform 3 retries before waiting for the user defined poll period.

SNTP Time Zone The SNTP time zone is a fixed offset from GMT that is added to the correct time to allow the expression of time in all geographic time zones.

6.3.9 Diagnostics Download

The diagnostics download page allows the system administrator to download snapshots of system diagnostics.

An example diagnostics download screen is shown in Figure 36.

The following diagnostics are available[9]:

Vector Error Histogram.

Rx Power

Rx Gain

Tx Power

Signal Strength Ration V/H

Link Loss

Rx Data Rate

Tx Data Rate

[9] All diagnostics are extracted from the associated status and statistics webpage histograms. They are translated in a CSV file containing at most 3600 entries that equates to one hours worth of diagnostics. Each entry is a one second average and the number of sample the 45 Mbps Backhaul makes in an one second period.

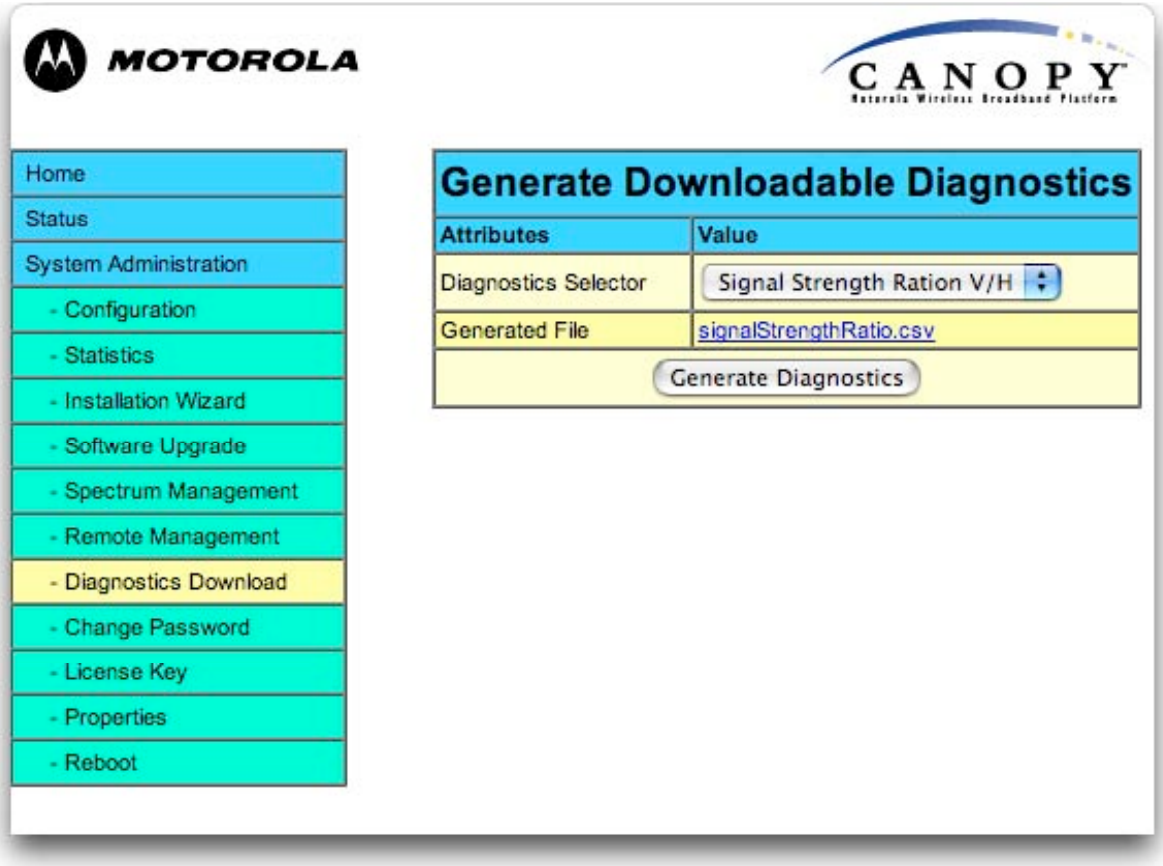


Figure 36: Diagnostics Download

6.3.10 Change System Administration Password

This page (Figure 37) is used to change the password for the system administration (The factory default is blank).

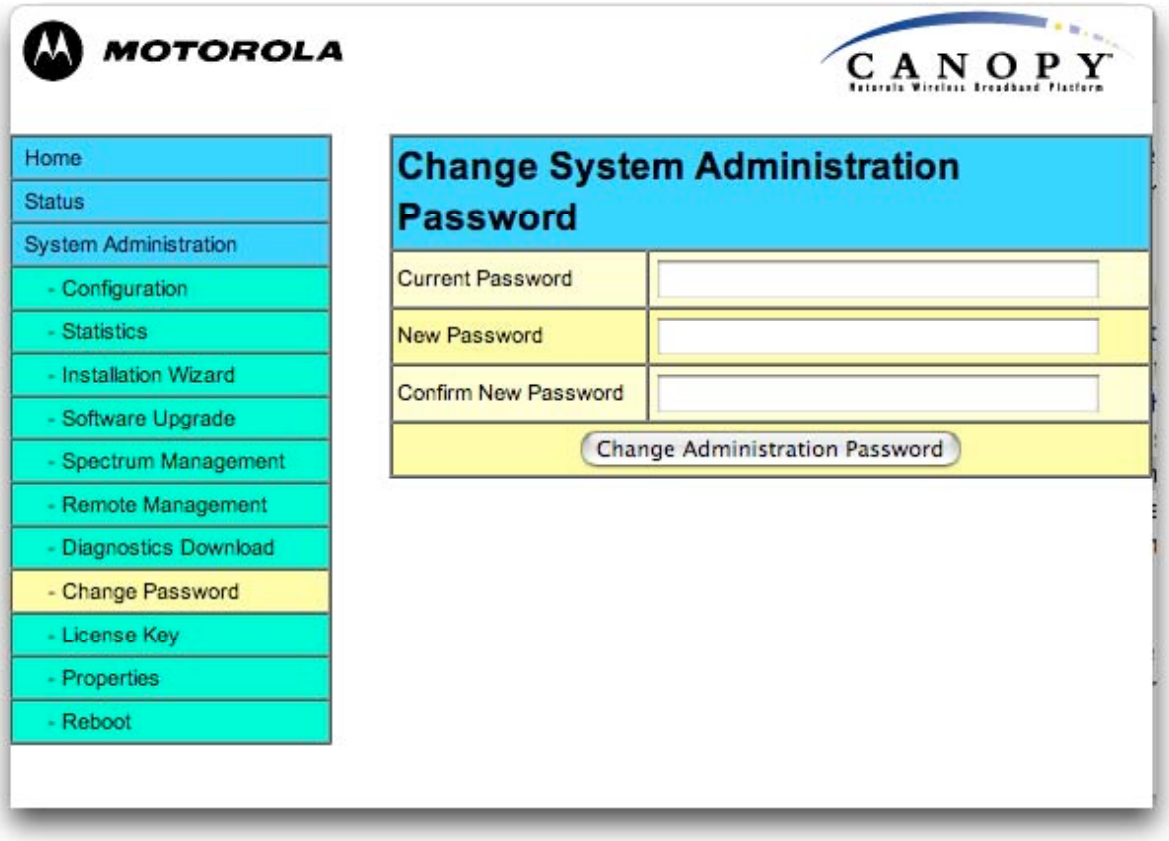


Figure 37 Password Change

To change the password any combination of alphanumeric characters, up to 31 characters in length, can be used.

6.3.11 License Key

The License Key data entry page allows the system administrator to update the 45 Mbps Backhaul license key. Figure 16 shows an example license key data entry page.

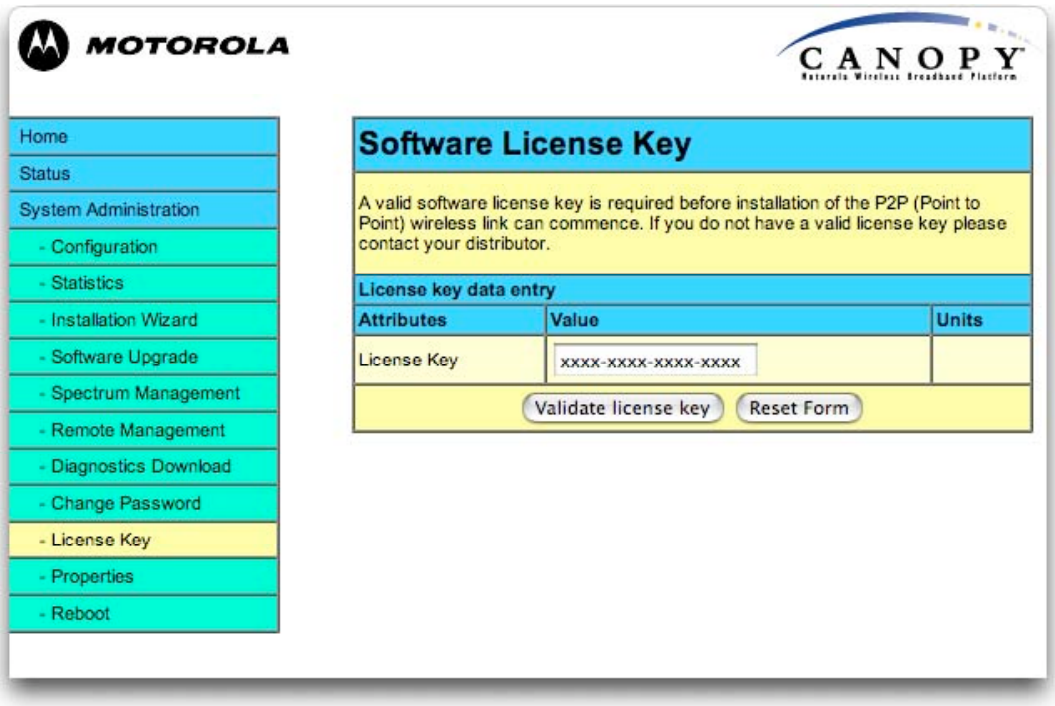


Figure 38: Software License Key Data Entry

The user must enter the license key and click the 'Validate License Key' button to check that the key is valid and program it to non-volatile memory.

If a valid license key is detected then the user will be presented by a system reboot screen see Figure 39.

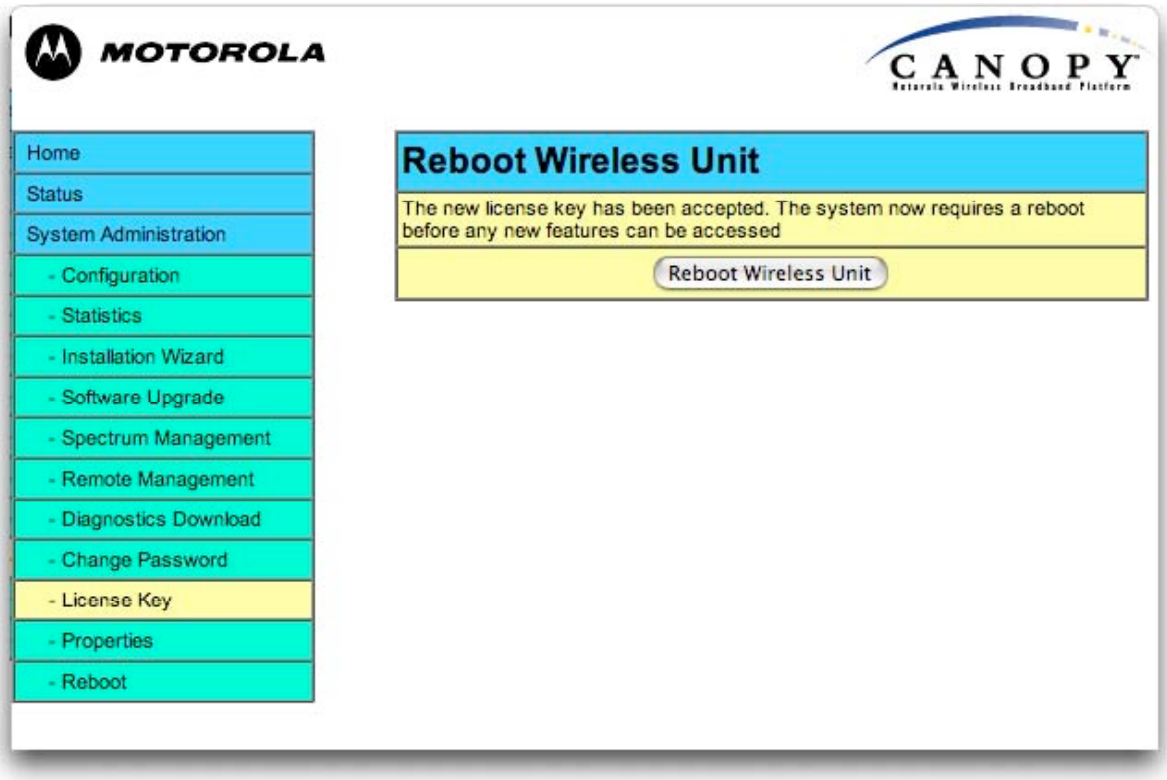


Figure 39: License Key Reboot Screen

6.3.12 Properties

The web page properties screen allows the user to configure the webpage interface.

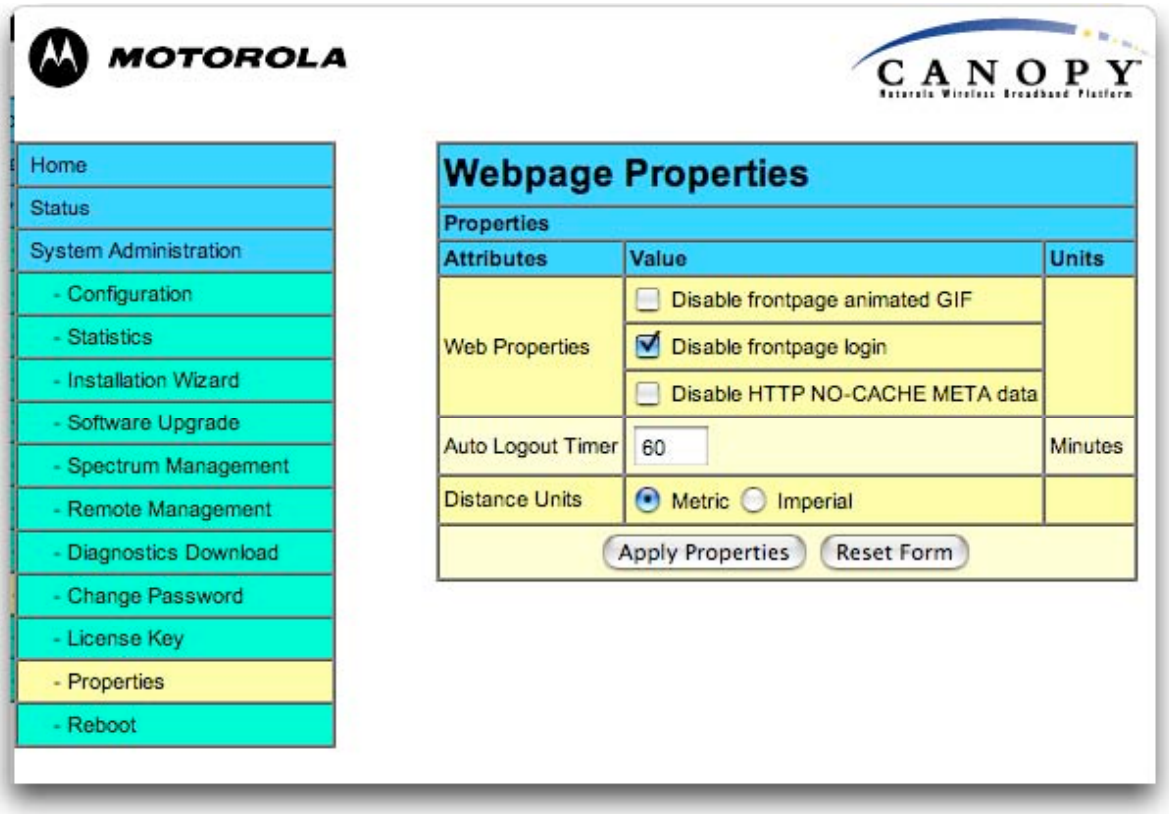


Figure 40: Properties

WEB Properties: Disable Front Page Animated GIF Replaces the homepage animated 45 Mbps Backhaul gif with a 45 Mbps Backhaul static.

WEB Properties: Disable Front Page Login Allow access to homepage and status page webpages without forcing a login as the system administrator.

WEB Properties: Disable HTTP NO-CACHE META data Removes the HTTP NO-CACHE META clause from all dynamically created webpages.

Auto Logout Timer Configures the time in minutes that the system administrator is automatically logged out if no webpage activity is detected.

Distance Units Swaps the default metric display of distance in to imperial units. For example Km into Miles.

6.3.13 Reboot

The reboot page allows the system administrator to perform commanded reboots of the wireless unit. The reboot page also allows the system administrator to view a list of past reboot reasons. The ‘reasons for reboot field has been implemented as a drop down selection box, where the latest reason for reboot is located at the top of the list.

If the SNTP service from the remote management section above is active then the command reboot commands will be accompanied by the date and time the reboot was requested.

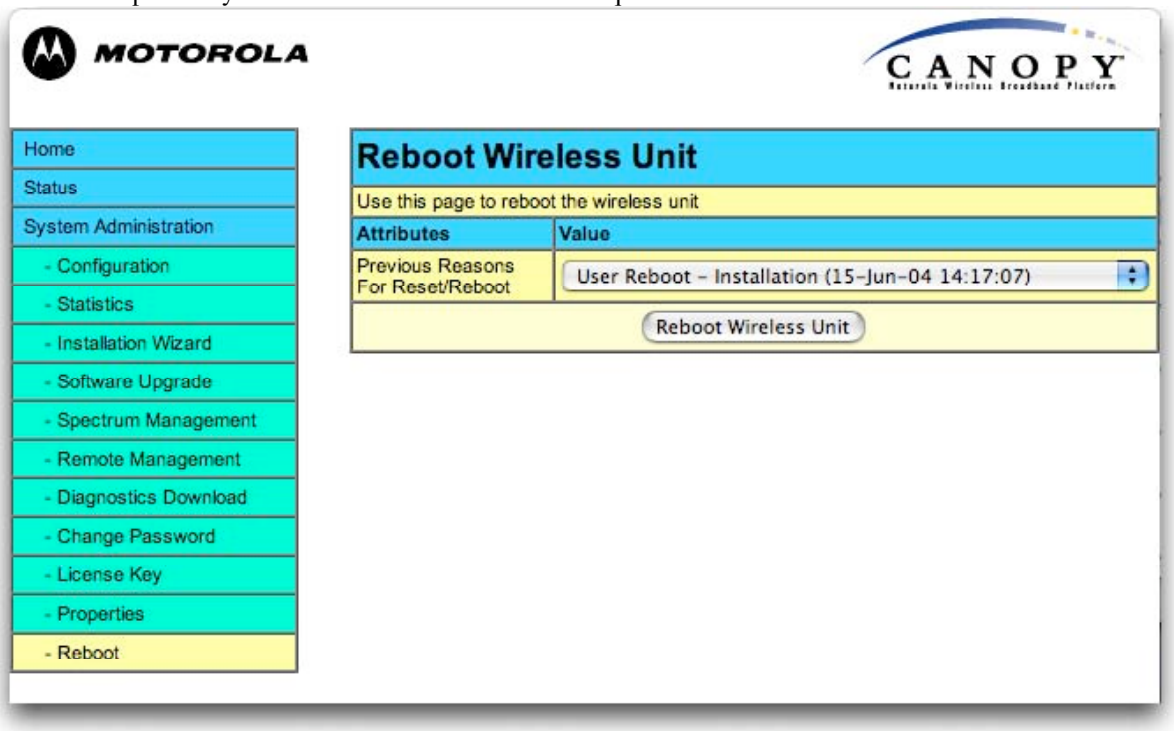


Figure 41 System Reboot

7 Fault Finding

If communication has been lost with the unit at the near end of the link then there may be a hardware fault with the wiring, network or hardware. Go to the hardware section below. If communication with the far end of the link is lost then go to the radio section below.

7.1 Hardware

If there are problems suspected with the link hardware the following procedure is recommended.

The following diagram illustrates the main system connections.

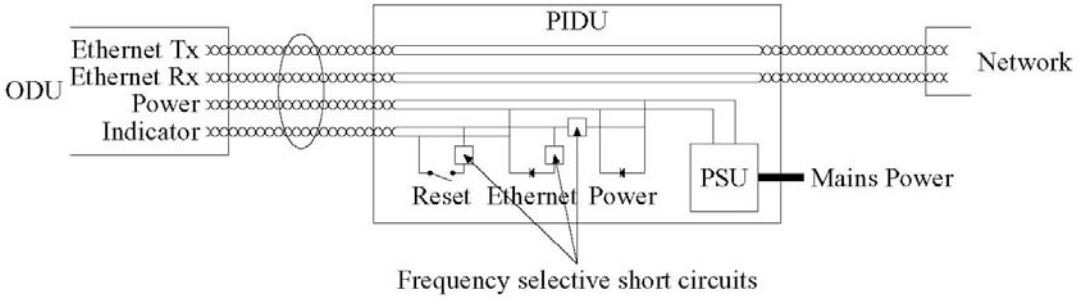


Figure 42 Main System Connections

7.1.1 Power

Check the power LED at each end of the link. If the power lights are illuminated go to the Ethernet section below. If at either end they are not illuminated then[10] check the Ethernet LED. If neither are illuminated then there is no voltage on the power wires to the ODU.

1. Check that the mains power is connected and switched on.
2. Check that the lamp illuminates if the ODU connector is disconnected at the PIDU. (Remove the PIDU cover).

    a. If it does illuminate then either the ODU is drawing to much current, or the power wiring to the ODU is short circuit or the PSU is supplying insufficient power. The likely fault can be determined by removing the jumper (J906), found inside the removable cover of the PIDU, and measuring the current taken with an ammeter placed across the 2 jumper pins. This is normally 10mA without the ODU connected and 300mA to 1A when the ODU is connected.
    b. If it does not illuminate then recheck that power is applied to the PIDU by measuring the voltage across +55V and 0V pads inside the removable cover in the PIDU. Check that the PIDU is not short circuit by measuring the impedance across the Power connector. Is the lamp faulty?

[10] The power indicator LED should be continually illuminated.

7.1.2 Ethernet

The Ethernet LED is driven from the ODU processor and thus is capable of informing you of many conditions using different flash sequences. If the Ethernet indicator does not illuminate at all there are four possible conditions.

1. There is no power reaching the ODU because of a wiring fault
2. The ODU is faulty
3. The PIDU is faulty
4. The Ethernet network side is faulty

Look at the following table to check the LED response for power up, disconnect the power and reapply and note what happens.

Differentiating between 1--3 and 4 can be achieved by removing the power for 1 second. Watch the Ethernet indicator for 1 minute, if it never flashes then the problem is 1—3. Take the jumper (J906) out of the PIDU and check the current taken by the ODU. This should be 300mA to 1A when starting through to running normally.

If the Ethernet indicator flashes to begin with but then stops flashing then ODU is powered and software loaded but ethernet connectivity has been lost between the ODU and the users connected equipment. All ethernet connections should be rechecked.

Power Indoor Unit LED check chart:

Mode	Green LED	Yellow LED No Ethernet Cable Connected	Yellow LED Ethernet Cable Connected between PIDU and NIC/Switch/Hub
No Power Applied	Off	Off	Off
Power Applied	On	Will flash once per second regularly approximately 16 seconds after power applied for 10 seconds then will go out and stay out	Will flash once per second regularly approximately 16 seconds after power applied for 10 seconds then operate as Ethernet Link/Activity LED
Valid Ethernet Link and no traffic	On	N/A	Will be on solid for a valid link.
Valid Ethernet Link with traffic	On	N/A	Will be on solid, but will blink randomly as traffic passes through
While Reset Switch Pressed	On	Off	Off
Reset Switch Pressed and released within 10 seconds during	On	Off	Off while switch pressed but returns to LINK/Activity state when released. No

normal operation			reset will take place
Reset Switch Pressed and held for > 20 seconds during normal operation	On	Off while switch pressed. One second after release, flashes twice per second regularly for 10 seconds, then erases non-volatile configuration data and resets. The erasure will reset all the unit's configuration apart from the last known wireless link configuration, this ensures that after a reset the wireless link SHOULD re-establish without any user intervention. The IP address will be reset to 10.10.10.10	
Reset Switch Pressed and held for >40 seconds from power on (Reset is pressed while power is applied)	On	Off while switch pressed. One second after release, flashes twice per second regularly for 10 seconds, then erases non-volatile configuration data & the downloaded image and resets. The erasure will reset all the unit's configuration apart from the last known wireless link configuration, this ensures that after a reset the wireless link SHOULD re-establish without any user intervention. The IP address will be reset to 10.10.10.10 and the unit will boot the fixed software image.	

7.2 Radio

7.2.1 No Activity

If communication over the radio link has been lost and the unit at the other end of the link can be managed on its local network. The following procedure should be adopted:

If there is no wireless activity then the configuration should be checked. It is essential that the following items are correct

- Check that the software at each end of the link is the same version
- Check that the Target Mac address has not been mis-configured at each end of the link.
- Check Range
- Check Tx Power
- Check License key
- Check Master Slave
- Check for Alarm conditions on Home page
- Check that the link has not been further obscured or the ODU misaligned.
- Check the DFS page at each end of the link and establish that there is a common quiet wireless channel to use.

If there are no faults found in the configuration and there is absolutely no wireless signal retry the installation procedure. If this doesn't work then the ODU may be faulty.

7.2.2 Some Activity

If there is some activity but the link is unreliable or doesn't achieve the data rates required then

- Check that the interference has not increased using the DFS measurements
- If a quieter channel is available check that it is not barred
- Check that the path loss is low enough for the communication rates required
- Check that the ODU has not become misaligned

8 Specifications

8.1 System Specifications

Radio Technology	Specification	
RF Band	5.725-5.850GHz	
Channel Selection	By dynamic frequency control and manual intervention Automatic detection on startup and continual adaptation to avoid interference.	
Dynamic Frequency Control	Initial capture 10-15 sec. Out of service on interference 100 ms.	
Channel size	11 MHz	
Tx power @ Antenna ports	**Mode**	**Maximum Power Output (region dependant)**[11]
	BPSK Mode	24 dBm
	QPSK Modes	23 dBm
	16QAM Modes	21 dBm
	64QAM Modes	19 dBm
Transmit Power Control	Loop bandwidth 1 Hz, Range 30dB typical	
Manual Power Control	Maximum power can be controlled lower than the power limits shown above in order to control interference to other users of the band.	
Receiver Noise Figure	Typically 6 dB	

[11] As specified by FCC Part 15.247

The receive sensitivities and system gains for each mode are as follows:

Mode	RX Sensitivity	TX Power	System Gain
BPSK 1/2	-95.5 dBm	24 dBm	166.5 dB
QPSK 1/2	-92.8 dBm	23 dBm	162.8 dB
QPSK 2/3	-90.7 dBm	23 dBm	160.7 dB
16QAM 1/2	-88.1 dBm	21 dBm	156.1 dB
16QAM 3/4	-83.6 dBm	21 dBm	151.6 dB
64QAM 2/3	-80.2 dBm	19 dBm	146.2 dB
64QAM 3/4	-78.3 dBm	19 dBm	144.3 dB
64QAM 7/8	-73.6 dBm	19 dBm	139.6 dB

The values quoted here are static sensitivity measurements. When AMOD is in operation, margins are applied to the up and down shifts between modes to ensure seamless changes without loss of data. The margins applied are dynamic and selected dependant on the prevailing link conditions.

The margins applied are as follows:

Fading	Mode Up Shift	Mode Down shift
Slow	1.5 dB	1.5 dB
Fast	6 dB	3 dB

For example: In a fast fading environment an up shift from 16QAM _ to 64QAM 2/3 will occur at –74.2 dBm (-80.2 dBm + 6 dB) and the down shift from 64QAM 2/3 to 16QAM _ will occur at –77.2 dBm (-80.2 dBm + 3 dB).

Antenna	
Antenna Type	Integrated flat plate antenna
Antenna Gain	23.5 dBi typical
Antenna Beamwidth	8 Degrees

Wireless PHY	
Max Path Loss	167dB
Duplex Scheme	TDD, Symmetric (1:1) and Asymmetric (2:1)
Range	81 miles (130km) optical Line-of-Sight 6 miles (10km) non-Line-of-Sight
Over-the-Air Encryption	Proprietary scrambling mechanism. Optional AES – via license update.
Weather Sensitivity	Sensitivity at higher modes may be reduced during high winds through trees due to Adaptive Modulation Threshold changes
Error Correction	FEC and ARQ

Management	
Status Indication	Power status Ethernet Link Status Data activity
Installation	Web server and browser for setup Audio tone feedback during installation Web server for confirmation
Radio Performance and Management	Via web server and browser, SNMP
Alarms	Via configurable email alerts, SNMP

Ethernet Bridging	
Protocol	IEEE802.1; IEEE802.1p; IEEE802.3 compatible
Interface	10/100BaseT (RJ-45), Supports MDI/MDIX Auto Crossover
Data Rate[12] 0 – 5 km Mode (Single direction – Symmetric TDD (1:1))	BPSK 1/2 1.60 Mbps QPSK 1/2 3.20 Mbps QPSK 2/3 4.27 Mbps 16QAM 1/2 6.40 Mbps 16QAM 3/4 9.60 Mbps 64QAM 2/3 12.81 Mbps 64QAM 3/4 14.41 Mbps 64QAM 7/8 16.81 Mbps
Data Rate[12] 0 – 5 km Mode (Single direction – Asymmetric TDD (2:1))	BPSK 1/2 2.07 Mbps QPSK 1/2 4.13 Mbps QPSK 2/3 5.51 Mbps 16QAM 1/2 8.26 Mbps 16QAM 3/4 12.39 Mbps 64QAM 2/3 16.53 Mbps 64QAM 3/4 18.59 Mbps 64QAM 7/8 21.69 Mbps
Data Rate[12] 0 – 40 km Mode (Single direction – Symmetric TDD (1:1))	Reduces by 6.40%
Data Rate[12] 0 – 40 km Mode (Single direction – Asymmetric TDD (2:1))	Reduces by 8.11%
Data Rate[12] 0 – 130 km Mode (Single direction – Symmetric TDD (1:1))	Reduces by 19.63%
Data Rate[12] 0 – 130 km Mode (Single direction – Asymmetric TDD (2:1))	Reduces by 23.97%

Note: Practical Ethernet rates will depend on network configuration, higher layer protocols and platforms used.

Physical	
Dimensions	Width 14.5” (370mm), Height 14.5” (370mm), Depth 3.75” (95mm)
Weight	12.1 lbs (5.5 Kg) including bracket

[12] ARQ disable – (Enabling ARQ drops the rate ~ 0.13%)

Power Supply	Separate power supply unit (included)
Power source	90 – 264 VAC, 50 – 60 Hz
Power consumption	30 W mean (85 BTU/Hr)

8.2 Safety Compliance

Region	Specification
USA	UL 60950
Canada	CSA C22.2 No.60950
International	CB certified & certificate to IEC 60950

8.3 EMC Emissions Compliance

Region	Specification
USA	FCC Part 15 Class B
Canada	CSA Std C108.8, 1993 Class B
Europe	EN55022 CISPR 22

8.4 EMC Immunity Compliance

Top-level Specification ETSI 301-489.

Specification	Comment
EN 55082-1 Generic EMC and EMI requirements for Europe	
EN 61000-4-2: 1995 Electro Static Discharge (ESD), Class 2, 8 kV air, 4 kV contact discharge	
EN 61000-4-3: 1995 ENV50140: 1993 (radiated immunity) 3 V/m	
EN 61000-4-4: 1995 (Bursts/Transients), Class 4, 4 kV level (power lines AC & DC)	Signal lines @ 0.5 kV open circuit voltage.
EN 6100045:1995, (Surge Immunity)	Requires shielded connection to users network
EN 61000-4-6: 1996 (Injected RF), power line, Class 3 @ 10 V/m	Signal lines, Class 3 @ 3 V RMS un-modulated.

8.5 Radio Certifications

Region	Specification (Type Approvals)
USA	FCC Part 15.247
UK	VNS 2107
Eire	ComReg 03/42

8.6 Environmental Specifications

Category	Specification
Temperature	ODU: -40°F(-40°C) to 140°F (+60°C) PIDU & PSU: 32°F(0°C) to 104°F(+40°C)
Wind Loading	151mph Max (242kph)
Humidity	100% Condensing

Waterproof	IP65 (ODU) , IP53 (PIDU)
UV Exposure	10 year operational life (UL746C test evidence)

8.7 System Connections

8.7.1 ODU to PIDU Connection

Figure 43 ODU to PIDU Connection Diagram

9 Lightning Protection

9.1 Overview

The idea of lightning protection is to protect structures, equipment and people against lightning by conducting the lightning current to ground via a separate preferential solid path and by reducing the electromagnetic field.

The following should be treated as a guide only, the actual degree of lightning protection required depends on local conditions and weather patterns. Full details of lightning protection methods and requirements can be found in the international standards IEC 61024-1 and IEC 61312-1, the U.S. National Electric Code ANSI/NFPA No. 70-1984 or section 54 of the Canadian Electric Code.

The installation of the ODU can be classified into two different lightning protection zones.

Zone A — In this zone a direct hit is possible.

Zone B — In this zone a direct hit is not possible, but the unattenuated electromagnetic field is still present.

The next diagrams (Figure 44 & Figure 45) show this zoning pictorially:

Equipment mounted in Zone A should be capable of carrying the full lightning current. Mounting of the ODU in Zone A is not recommended. Mounting in Zone A should only be carried out observing the rules governing installations in Zone A[13]. Failure to do so may put structures, equipment and life at risk.

Equipment mounted in Zone B should be grounded using grounding wire of at least 10 AWG. This grounding wire should be connected to a grounding rod or the building grounding system before entry in to building.

The 45 Mbps Backhaul ODU grounding point can be found on the bottom of the unit. The 45 Mbps Backhaul is supplied with an appropriate grounding lug for attachment to the ODU.

9.2 Detailed Installation

The recommended components for an installation protected for nearby strikes are:

- 2 Grounding Kits — Andrew Type 223158 (www.andrew.com)
- Shielded Cat 5 Cable
- Line Protection Unit — Cyclix MTJ-POE 60V (www.cylix.com)
- Grounding Stake
- 2 RJ45 connectors
- 10 AWG Grounding Cable

[13] Local regulations may also require the fitting of the 10AWG ground wire referred below.

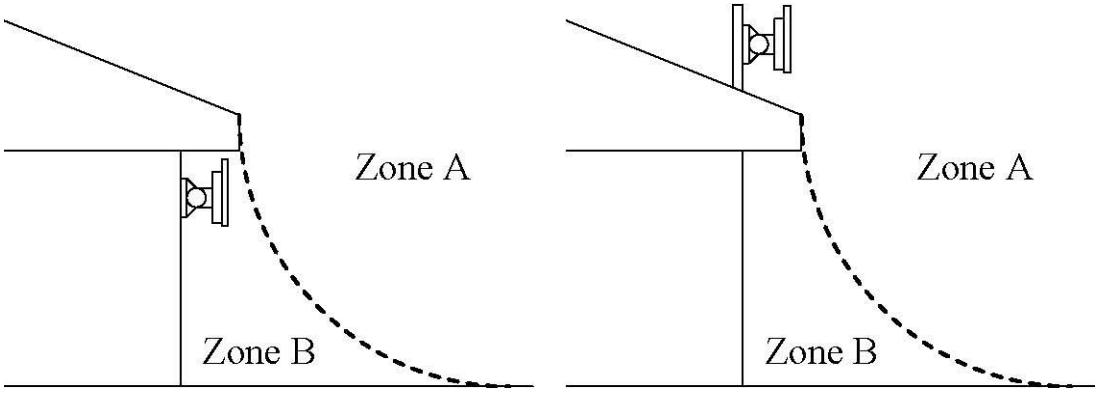


Figure 44 ODU Mounted in Zone B & ODU Mounted in Zone A

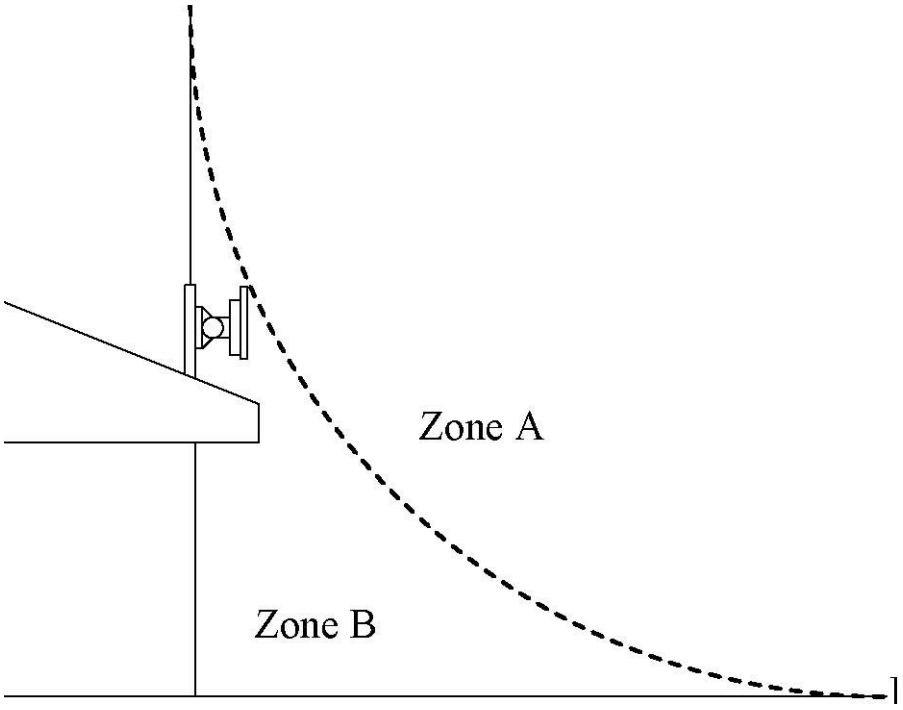


Figure 45 ODU mounted inside Zone B

	Zone A	Zone B
Ground (Earth) ODU	Mandatory	Recommended
Shielded Cable	Mandatory	Recommended
Ground (Earth) Cable at Building Entry	Mandatory	Recommended
Ethernet Surge Arrestor	Recommended	Recommended

Table 8 Protection Requirements

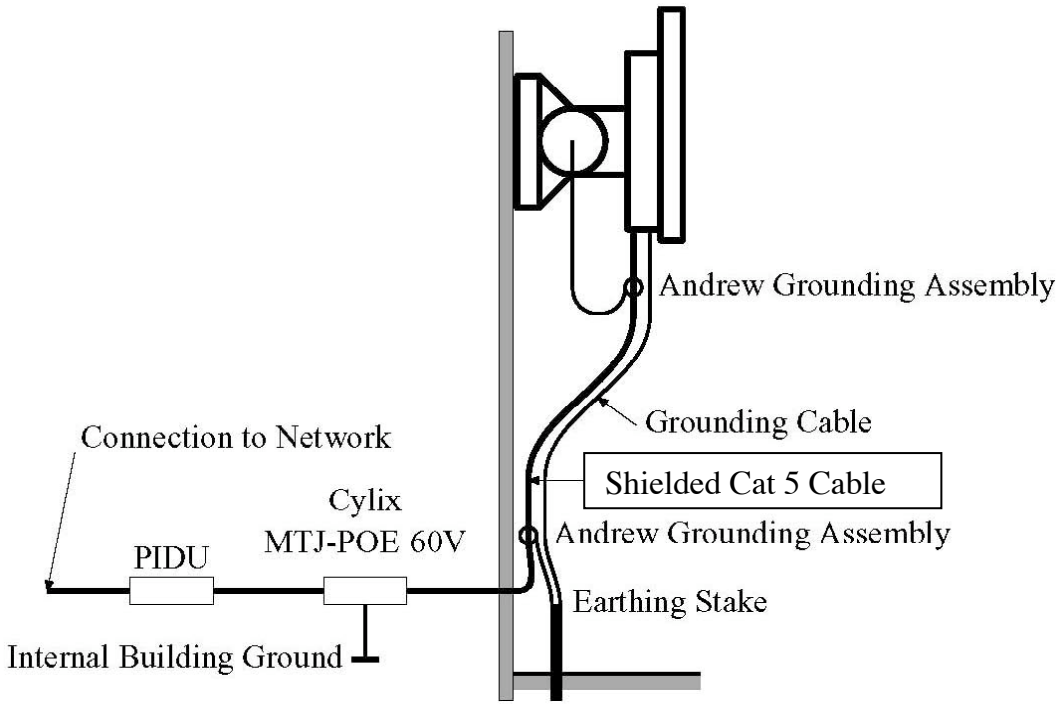


Figure 46 Diagram showing a typical installation

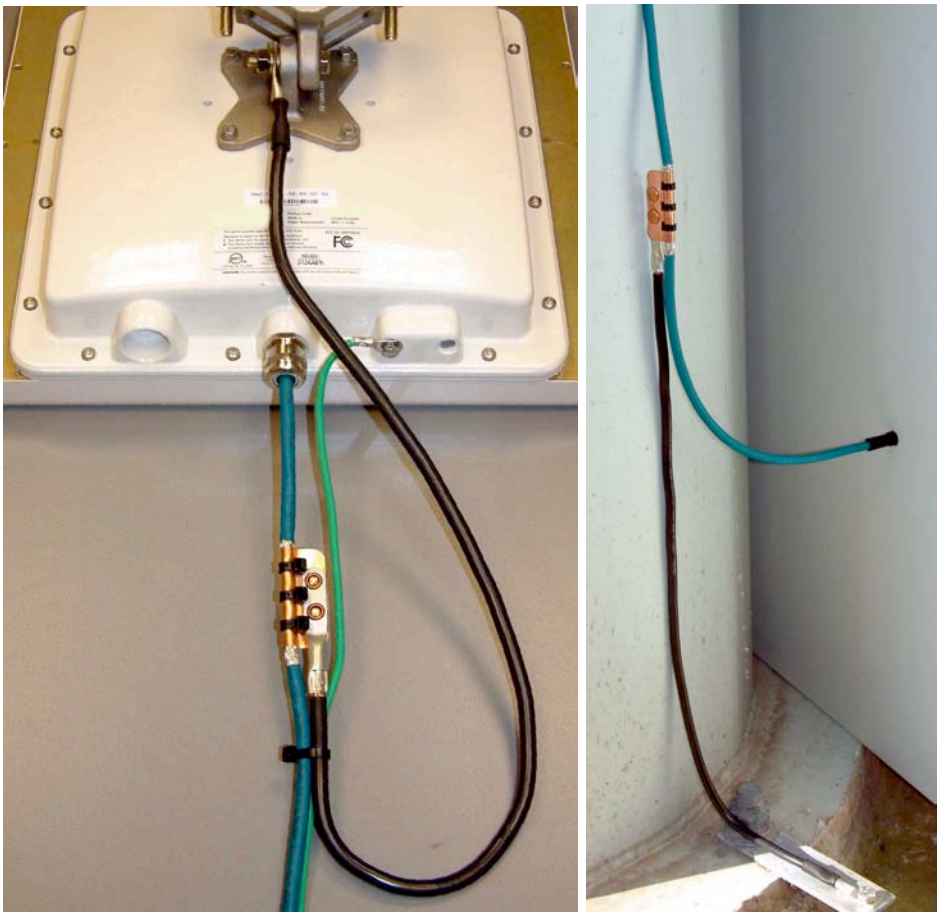


Figure 47 Upper Configuration and Lower Configuration

10 Wind Loading

10.1 General

Antennas and electronic equipment mounted on towers or pole mounted on buildings will subject the mounting structure to lateral forces when there is appreciable wind. Antennas are normally specified by the amount of force (in pounds) for specific wind strengths.

The magnitude of the force depends on both the wind strength and size of the antenna.

10.2 Calculation of Lateral Force

The 45 Mbps Backhaul unit with or without the integral antenna is essentially a flat structure and so the magnitude of the lateral force can be estimated from:

$$\text{Force (in pounds)} = 0.0042 \cdot A \cdot v^2$$

Where A is the surface area in square feet and v is the wind speed in miles per hour.

The lateral force produced by a single 45 Mbps Backhaul Unit at different wind speeds is shown below:

Item	Largest Surface Area (sq ft)	Lateral Force (Pound) at windspeed (mph)				
		80	100	120	140	150
45 Mbps Backhaul with integrated antenna	1.36	37	57	82	112	129
Connectorized 45 Mbps Backhaul	1.00	27	42	60	82	95

The equivalent table in metric units is:

Item	Largest Surface Area (sq m)	Lateral Force (kg) at windspeed (m/s)				
		30	40	50	60	70
45 Mbps Backhaul with integrated antenna	0.1300	12	22	34	49	66
Connectorized 45 Mbps Backhaul	0.0930	9	16	24	35	48

Note : When the connectorized version of 45 Mbps Backhaul is used with external antennas, the figures from the antenna manufacturer for lateral force should be included to calculate to total loading on the mounting structure.

10.3 45 Mbps Backhaul Capabilities

The structure and mounting brackets of the ODU are capable of withstanding wind speeds up to 151mph (242kph). The installer should ensure that the structure the ODU is attached to is also capable of withstanding the prevalent wind speeds and loads.

10.4 Wind Speed Statistics

Installers are recommended to contact the national meteorological office for the country concerned to identify the likely wind speeds prevalent at the proposed location. This will enable the installer to estimate the total wind loading on the support structures.

Examples of the sort of statistics that are available are:

USA

Reported Fastest Single Wind Velocities for Selected U.S. Cities

(Source: National Weather Service)

City, State	**Wind Velocity (mph)**
Bismarck, North Dakota	72
Buffalo, New York	91
Chicago, Illinois	87
Hatteras, North Carolina	110
Miami, Florida	132
New York, New York	99
Pensacola, Florida	114

UK

Meteorological Office, www.meto.gov.uk

Peak windspeed contour maps can be found as Fig 3a/3b at:

http://www.meto.gov.uk/education/historic/1987.html

11 Connectorized 45 Mbps Backhaul

11.1 Scope

This Chapter details the changes and additional features relevant to the connectorized version of the Canopy 45 Mbps Backhaul.

11.2 Product Description

11.2.1 Hardware

The connectorized version of the 45 Mbps Backhaul is designed to provide the system integrator and installer with the ability to provide extra capability to cope with very difficult radio links compared to the 45 Mbps Backhaul integrated version. The connectorized version allows the use of a variety of externally mounted antennas, either Flat Plate or Dish, which have higher gains than provided by the integrated antenna.

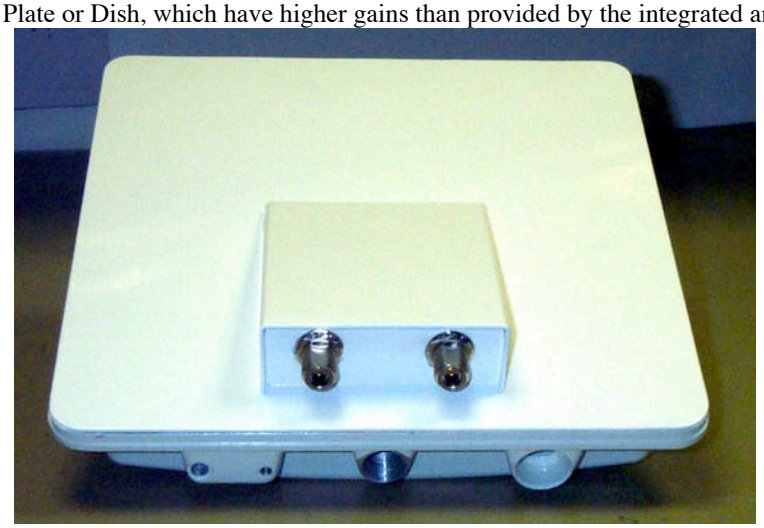


Figure 48 Connectorized 45 Mbps Backhaul Outdoor Unit

11.2.2 Antenna Choices

The integrated antenna has a gain of 23dBi. External antennas from the list in Table 10 can be used with the connectorized 45 Mbps Backhaul. These are approved by the FCC for use with the product and are basically constrained by the following limits:

- Single Polarization Flat Plate Antennas – up to 28dBi per antenna
- Single/Dual Polarization Parabolic Dish Antennas – up to 37.7dBi per polarization or antenna

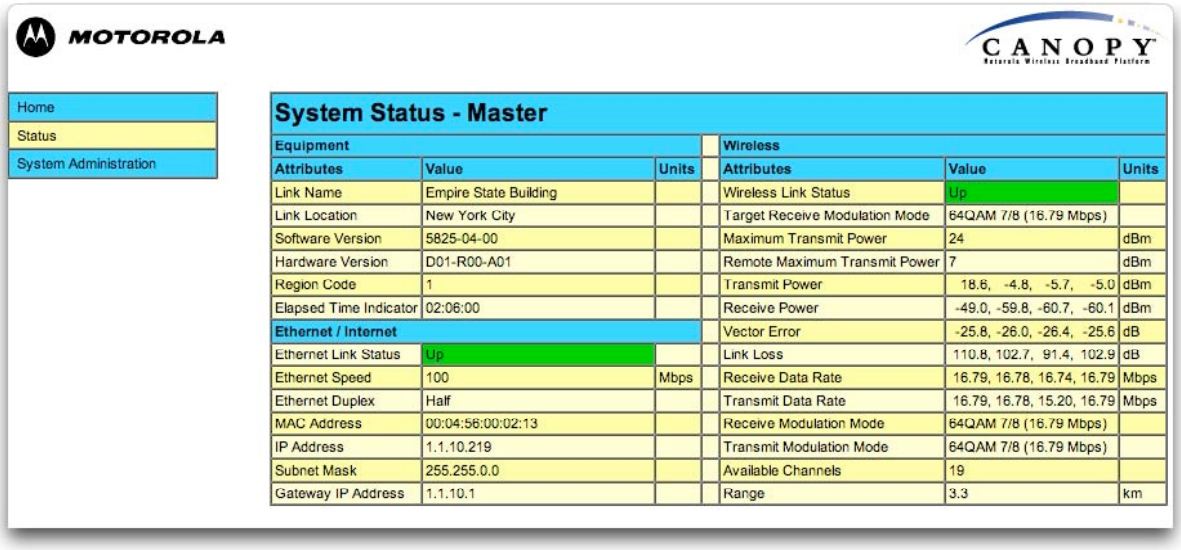
All external antennas – cable loss between the ODU and the antenna ports must not be less than 1.2dB

11.3 Software/Features

For most operations and features, the connectorized version and the integrated antenna version are identical. This section covers the areas where they are different.

11.3.1 Status Page

The link loss calculation presented on the Status Page on the management interface has to be modified to allow for the increased antenna gains at each end of the link. The manufacturing process of the connectorized 45 Mbps Backhaul configures the standard hardware of the unit for use with external antennas. The installer is prompted, as part of the installation process, to enter the gain of the external antenna(s) and cable losses at each end of the link. Peer-2-Peer messaging is used to pass the effective antenna gain to each end of the link so that the link loss calculations can be correctly computed.



Equipment			Wireless		
Attributes	Value	Units	Attributes	Value	Units
Link Name	Empire State Building		Wireless Link Status	Up	
Link Location	New York City		Target Receive Modulation Mode	64QAM 7/8 (16.79 Mbps)	
Software Version	5825-04-00		Maximum Transmit Power	24	dBm
Hardware Version	D01-R00-A01		Remote Maximum Transmit Power	7	dBm
Region Code	1		Transmit Power	18.6, -4.8, -5.7, -5.0	dBm
Elapsed Time Indicator	02:06:00		Receive Power	-49.0, -59.8, -60.7, -60.1	dBm
Ethernet / Internet			Vector Error	-25.8, -26.0, -26.4, -25.6	dB
Ethernet Link Status	Up		Link Loss	110.8, 102.7, 91.4, 102.9	dB
Ethernet Speed	100	Mbps	Receive Data Rate	16.79, 16.78, 16.74, 16.79	Mbps
Ethernet Duplex	Half		Transmit Data Rate	16.79, 16.78, 15.20, 16.79	Mbps
MAC Address	00:04:56:00:02:13		Receive Modulation Mode	64QAM 7/8 (16.79 Mbps)	
IP Address	1.1.10.219		Transmit Modulation Mode	64QAM 7/8 (16.79 Mbps)	
Subnet Mask	255.255.0.0		Available Channels	19	
Gateway IP Address	1.1.10.1		Range	3.3	km

Figure 49 Connectorized 45 Mbps Backhaul Status Page

11.3.2 Configuration Pages

The amended Configuration Web page is shown below as Figure 50.

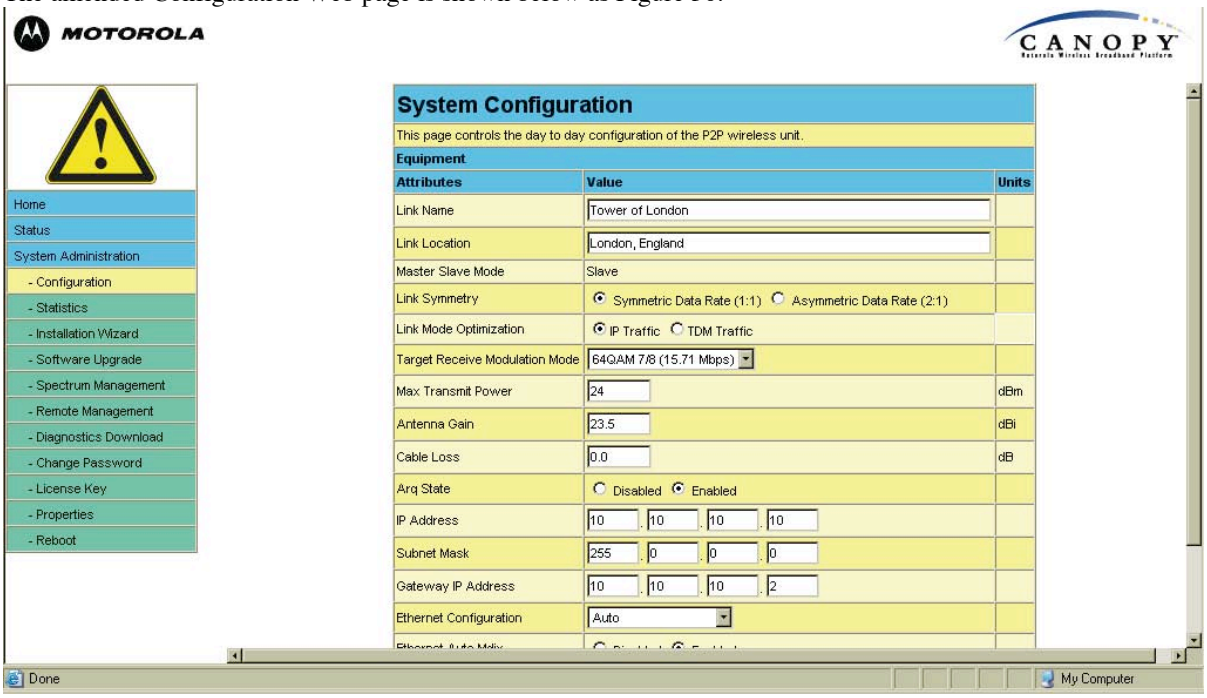


Figure 50 Connectorized 45 Mbps Backhaul 'System Configuration' Page

11.3.3 Installation Pages

The installer is prompted to enter the Antenna Gain and Cable Loss (45 Mbps Backhaul C to antenna) at each end of the link. The Installation Page(s) is shown as Figure 51-Figure 53.

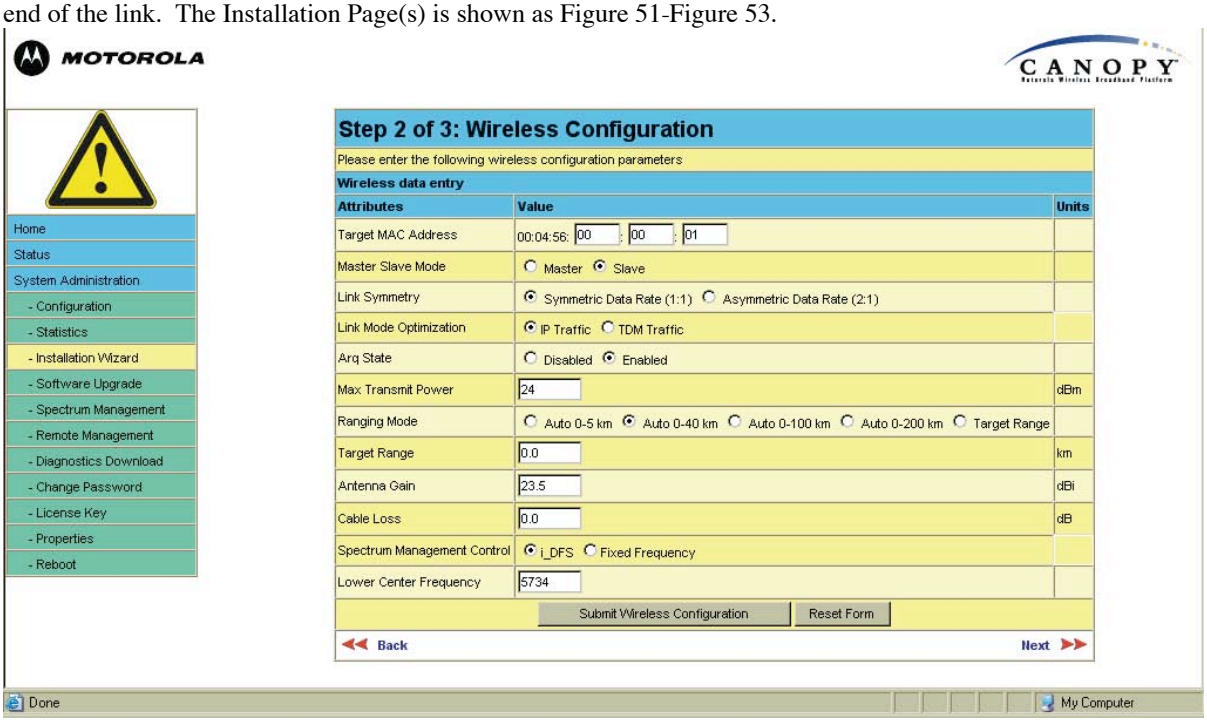


Figure 51 Connectorized 45 Mbps Backhaul 'Installation Wizard' Page

Antenna Gain Gain of the antenna you are connecting to the unit, see Table 11 Allowed Antennas for Deployment in USA/Canada.

Cable Loss Loss in the cable between the ODU and the antenna. Note: In the event that there is a significant difference in length of the antenna cables for the two antenna ports, then the average value should be entered.

Spectrum Management Control Is used to configure the 45 Mbps Backhaul Spectrum Management features, see section 6.3.5 for more details. i_DFS is the abbreviation for intelligent Dynamic Frequency Selection, this feature continually monitors the 5.8 GHz spectrum looking for a the channel with the lowest level of on channel and co-channel interference. Fixed frequency mode allows the installer to fix the transmit and receive frequencies on the units. The frequencies may be configured symmetrically or asymmetrically.

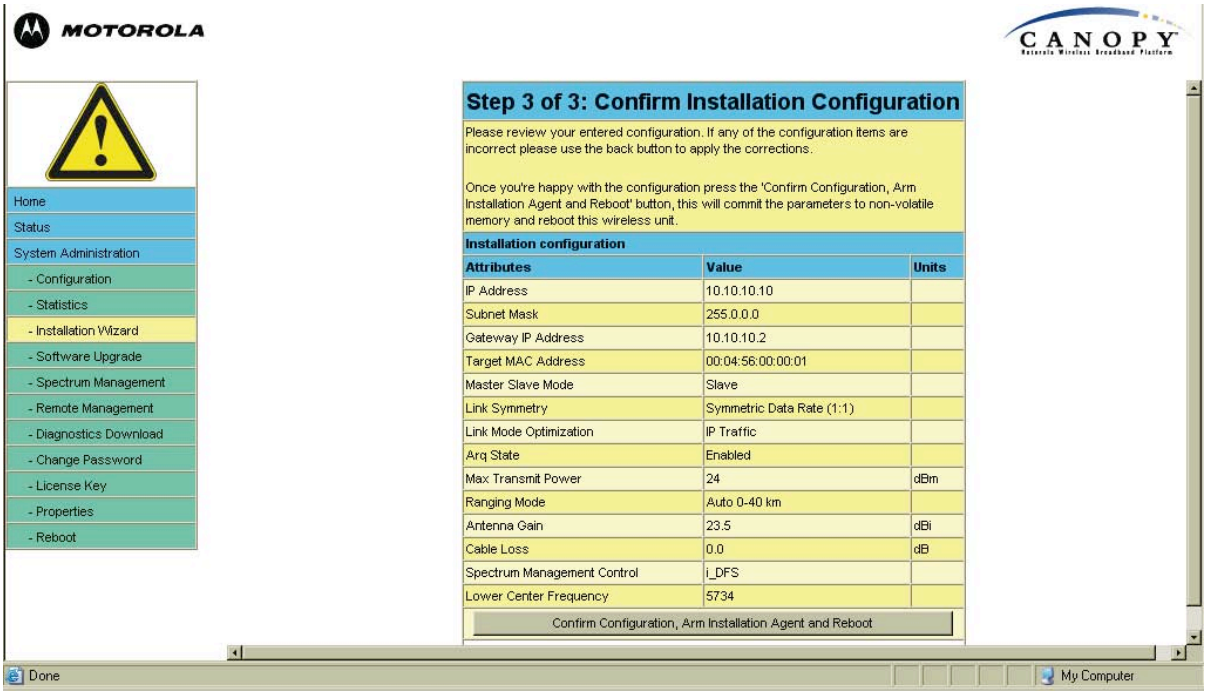

MOTOROLA
CANOPY
Home
Status
System Administration
- Configuration
- Statistics
- Installation Wizard
- Software Upgrade
- Spectrum Management
- Remote Management
- Diagnostics Download
- Change Password
- License Key
- Properties
- Reboot
Step 3 of 3: Confirm Installation Configuration
Please review your entered configuration. If any of the configuration items are incorrect please use the back button to apply the corrections.
Once you're happy with the configuration press the 'Confirm Configuration, Arm Installation Agent and Reboot' button, this will commit the parameters to non-volatile memory and reboot this wireless unit.
Installation configuration
Attributes | Value | Units
IP Address | 10.10.10.10
Subnet Mask | 255.0.0.0
Gateway IP Address | 10.10.10.2
Target MAC Address | 00:04:56:00:00:01
Master Slave Mode | Slave
Link Symmetry | Symmetric Data Rate (1:1)
Link Mode Optimization | IP Traffic
Arq State | Enabled
Max Transmit Power | 24 | dBm
Ranging Mode | Auto 0-40 km
Antenna Gain | 23.5 | dBi
Cable Loss | 0.0 | dB
Spectrum Management Control | i_DFS
Lower Center Frequency | 5734
Confirm Configuration, Arm Installation Agent and Reboot
Done
My Computer

Figure 52 Connectorized 45 Mbps Backhaul 'Confirm Installation' Page

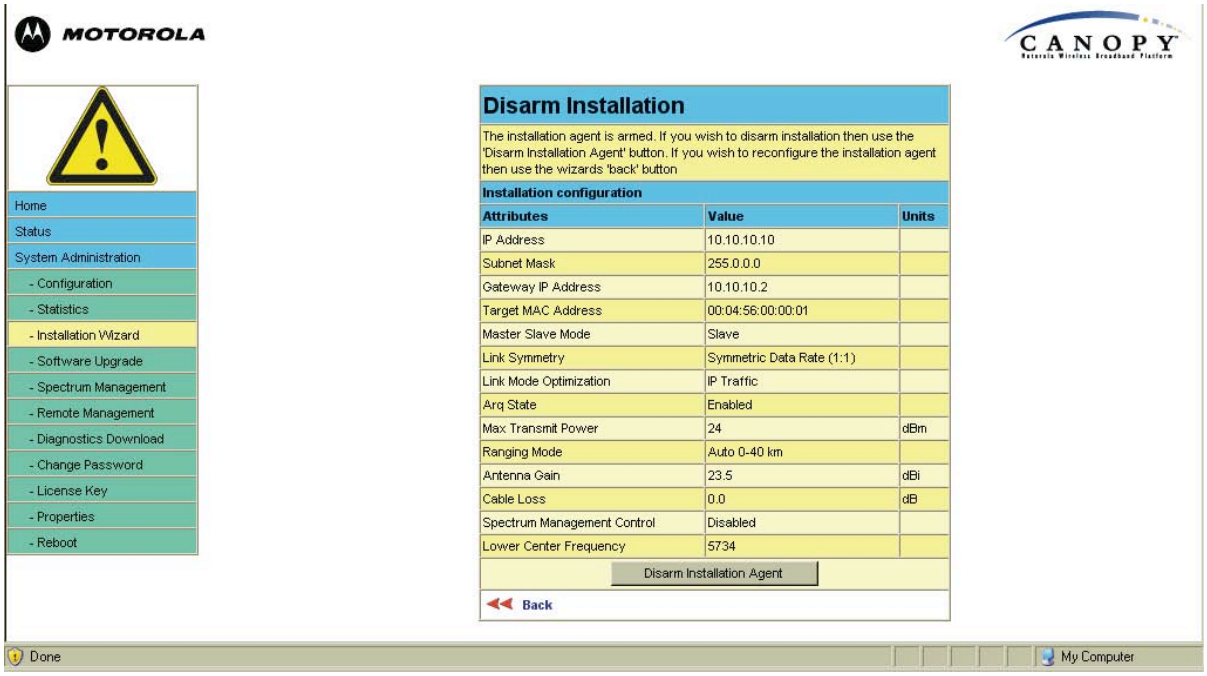

MOTOROLA
CANOPY
Home
Status
System Administration
- Configuration
- Statistics
- Installation Wizard
- Software Upgrade
- Spectrum Management
- Remote Management
- Diagnostics Download
- Change Password
- License Key
- Properties
- Reboot
Disarm Installation
The installation agent is armed. If you wish to disarm installation then use the 'Disarm Installation Agent' button. If you wish to reconfigure the installation agent then use the wizards 'back' button
Installation configuration
Attributes | Value | Units
IP Address | 10.10.10.10
Subnet Mask | 255.0.0.0
Gateway IP Address | 10.10.10.2
Target MAC Address | 00:04:56:00:00:01
Master Slave Mode | Slave
Link Symmetry | Symmetric Data Rate (1:1)
Link Mode Optimization | IP Traffic
Arq State | Enabled
Max Transmit Power | 24 | dBm
Ranging Mode | Auto 0-40 km
Antenna Gain | 23.5 | dBi
Cable Loss | 0.0 | dB
Spectrum Management Control | Disabled
Lower Center Frequency | 5734
Disarm Installation Agent
Back
Done
My Computer

Figure 53 Connectorized 45 Mbps Backhaul 'Disarm Installation' Page

11.4 Deployment Considerations

The majority of radio links can be successfully deployed with the 45 Mbps Backhaul product. It should only be necessary to use external antennas where the Link Budget Calculator indicates marginal performance for a specific link. Examples of this would be where the link is heavily obscured by dense woodland on an NLOS link or extremely long LOS links (>80km) over water.

The external antennas can be either dual-polarization (as the integrated antenna) or two single polarized antennas can be used in a spatially diverse configuration. It is expected that the dual-polarization antennas would normally be used to simplify the installation process; spatially diverse antennas may provide additional fade margin on very long LOS links where there is evidence of correlation of the fading characteristics on Vertical and Horizontal polarizations.

Dual polarization antennas (with a gain greater than the integrated antenna) are currently only available in parabolic dish form.

11.5 Link Budget

This is increased by the additional gain of the external antenna(s) less the cable losses. The improvement in link budget is indicated for a sample of the antennas when operating in BPSK 1/2 and 64QAM 7/8 modes.

Operating Mode	Static Link Budget (dB)			
	Integrated Antenna	28dBi Flat Plate	4 ft Parabolic Dish	6ft Parabolic Dish
BPSK ?	166.5	173.1	185.9	192.5
QPSK ?	162.8	169.4	182.2	188.8
QPSK 2/3	160.7	167.3	180.1	186.7
16QAM ?	156.1	162.7	175.5	182.1
16QAM ?	151.6	158.2	171.0	177.6
64QAM 2/3	146.2	152.8	165.6	172.2
64QAM ?	144.3	150.9	163.7	170.3
64QAM 7/8	139.6	146.2	159.0	165.6

Note: Gains are 23.5/28/34.4/37.7dBi and Cable Loss is 1.2dB for the External Antennas

Table 9 Static Link Budget for Various Antenna Options

11.6 Regulatory Issues

In countries where FCC regulations are not relevant, installations should conform to any applicable local regulations for the Equivalent Isotropic Radiated Power (EIRP).

Products deployed in North America or where FCC Part 15 regulations are used for unlicensed radio equipments, the sections 11.6.1and 11.6.2 apply.

11.6.1 Antenna Choice

The antennas allowed to be deployed with the connectorized 45 Mbps Backhaul are shown in Table 11.

11.6.2 Cable Losses

The FCC approval for the product is based on tests with a cable loss between the units of 1.2dB at 5.8GHz. The use of lower cable losses would result in the installation being outside the FCC rules.

As an indication, 1.2dB of cable loss corresponds to the following cable lengths excluding connector losses (source: Times Microwave).

Cable	Length for 1.2dB Cable Loss at 5.8GHz	
	(ft)	(m)
LMR100	1.9	0.6
LMR200	4.6	1.4
LMR300	7.25	2.2
LMR400	11.1	3.4

Table 10 Cable Losses per Length

11.7 Antennas for USA / Canada

Manufacturer	Antenna Type	Gain (dBi)	Flat Plate	Parabolic Dish
Andrew	Andrew 1-foot Flat Panel, FPA5250D12-N (23.6dBi)	23.6	Y	
Andrew	Andrew 2-foot Flat Panel, FPA5250D24-N (28dBi)	28	Y	
Gabriel	Gabriel 1-foot Flat Panel, DFPD1-52 (23.5dBi)	23.5	Y	
Gabriel	Gabriel 2-foot Flat Panel, DFPD2-52 (28dBi)	28	Y	
MTI	MTI 17 inch Diamond Flat Panel, MT-485009 (23dBi)	23	Y	
MTI	MTI 15 inch Dual-Pol Flat Panel, MT-485025/NVH (23dBi)	23	Y	
MTI	MTI 2 ft Directional Flat Panel, MT-20004 (28dBi)	28	Y	
MTI	MTI 2 ft Flat Panel, MT-486001 (28dBi)	28	Y	
RFS	RFS 1-foot Flat Panel, MA0528-23AN (23dBi)	23	Y	
RFS	RFS 2-foot Flat Panel, MA0528-28AN (28dBi)	28	Y	
Telectronics	Teletronics 2-foot Flat Plate Antenna, ANT-P5828 (28dBi)	28	Y	
Andrew	Andrew 2-foot Parabolic, P2F-52 (29.4dBi)	29.4		Y
Andrew	Andrew 2-foot Dual-Pol Parabolic, PX2F-52 (29.4dBi)	29.4		Y
Andrew	Andrew 3-foot Parabolic, P3F-52 (33.4dBi)	33.4		Y
Andrew	Andrew 3-foot Dual-Pol Parabolic, PX3F-52 (33.4dBi)	33.4		Y
Andrew	Andrew 4-foot Parabolic, P4F-52 (34.9dBi)	34.9		Y
Andrew	Andrew 4-foot Dual-Pol Parabolic, PX4F-52 (34.9dBi)	34.9		Y
Andrew	Andrew 6-foot Parabolic, P6F-52 (37.6dBi)	37.6		Y
Andrew	Andrew 6-foot Dual-Pol Parabolic, PX6F-52 (37.6dBi)	37.6		Y
Gabriel	Gabriel 2-foot High Performance QuickFire Parabolic, HQF2-52-N	28.2		Y
Gabriel	Gabriel 4-foot High Performance QuickFire Parabolic, HQF4-52-N	34.4		Y
Gabriel	Gabriel 6-foot High Performance QuickFire Parabolic, HQF6-52-N	37.4		Y
Gabriel	Gabriel 2-foot High Performance Dual QuickFire Parabolic, HQFD2-52-N	28.1		Y
Gabriel	Gabriel 4-foot High Performance Dual QuickFire Parabolic, HQFD4-52-N	34.3		Y
Gabriel	Gabriel 6-foot High Performance Dual QuickFire Parabolic, HQFD6-52-N	37.3		Y
Gabriel	Gabriel 2-foot Standard QuickFire Parabolic, QF2-52-N	28.5		Y
Gabriel	Gabriel 2-foot Standard QuickFire Parabolic, QF2-52-N-RK	28.5		Y
Gabriel	Gabriel 2.5-foot Standard QuickFire Parabolic, QF2.5-52-N	31.2		Y
Gabriel	Gabriel 4-foot Standard QuickFire Parabolic, QF4-52-N	34.8		Y
Gabriel	Gabriel 4-foot Standard QuickFire Parabolic, QF4-52-N-RK	34.8		Y
Gabriel	Gabriel 6-foot Standard QuickFire Parabolic, QF6-52-N	37.7		Y
Gabriel	Gabriel 2-foot Standard Dual QuickFire Parabolic, QFD2-52-N	28.4		Y
Gabriel	Gabriel 2.5-foot Standard Dual QuickFire Parabolic, QFD2.5-52-N	31.1		Y
Gabriel	Gabriel 2-foot Standard Dual QuickFire Parabolic, QFD2-52-N-RK	28.4		Y
Gabriel	Gabriel 4-foot Standard Dual QuickFire Parabolic, QFD4-52-N	34.7		Y
Gabriel	Gabriel 4-foot Standard Dual QuickFire Parabolic, QFD4-52-N-RK	34.7		Y
Gabriel	Gabriel 6-foot Standard Dual QuickFire Parabolic, QFD6-52-N	37.7		Y
RadioWaves	Radio Waves 2-foot Dual-Pol Parabolic, SPD2-5.2 (28.1dBi)	28.1		Y
RadioWaves	Radio Waves 2-foot Parabolic, SP2-5.2 (29.0dBi)	29		Y
RadioWaves	Radio Waves 3-foot Dual-Pol Parabolic, SPD3-5.2 (31.1dBi)	31.1		Y
RadioWaves	Radio Waves 3-foot Parabolic, SP3-5.2 (31.4dBi)	31.4		Y
RadioWaves	Radio Waves 4-foot Dual-Pol Parabolic, SPD4-5.2 (34.4dBi)	34.4		Y
RadioWaves	Radio Waves 4-foot Parabolic, SP4-5.2 (34.8dBi)	34.8		Y
RadioWaves	Radio Waves 6-foot Dual-Pol Parabolic, SPD6-5.2 (37.5dBi)	37.5		Y
RadioWaves	Radio Waves 6-foot Parabolic, SP6-5.2 (37.7dBi)	37.7		Y
RadioWaves	Radio Waves 2-foot Parabolic, SP2-2/5 (28.3dBi)	28.3		Y
RadioWaves	Radio Waves 3-foot Parabolic, SP3-2/5 (31.4dBi)	31.4		Y
RadioWaves	Radio Waves 4-foot Parabolic, SP4-2/5 (34.6dBi)	34.6		Y
RadioWaves	Radio Waves 6-foot Parabolic, SP6-2/5 (37.7dBi)	37.7		Y
RFS	RFS 2-foot Parabolic, SPF2-52AN or SPFX2-52AN (27.9dBi)	27.9		Y
RFS	RFS 3-foot Parabolic, SPF3-52AN or SPFX3-52AN(31.4dBi)	31.4		Y
RFS	RFS 4-foot Parabolic, SPF4-52AN or SPFX4-52AN(33.9dBi)	33.9		Y
RFS	RFS 6-foot Parabolic, SPF6-52AN or SPFX6-52AN (37.4dBi)	37.4		Y
RFS	RFS 2-foot HP Parabolic, SDF2-52AN or SDFX2-52AN (31.4dBi)	31.4		Y
RFS	RFS 4-foot HP Parabolic, SDF4-52AN or SDFX4-52AN (33.9dBi)	33.9		Y
RFS	RFS 6-foot HP Parabolic, SDF6-52AN or SDFX6-52AN (37.4dBi)	37.4		Y
StellaDoradus	StellaDoradus 45 inch Parabolic Antenna, 58PSD113	33.8		Y

Table 11 Allowed Antennas for Deployment in USA/Canada

11.8 Installation

The section covers the generic installation instructions for the connectorized 45 Mbps Backhaul. The actual installation procedure will depend on antenna choice, cable choice, required antenna separation etc.

11.8.1 Antenna Choice

Table 11 shows a wide variety of antennas that can be used with the connectorized 45 Mbps Backhaul. The main selection criteria will be the required antenna gain. The secondary criteria should be the ease of mounting and alignment. For example the Radio Waves Parabolic dishes are supplied with a mount that allows adjustment for alignment independent of the actual antenna mounting. This type of antenna is much easier to align than those that have to be rotated around the mounting pole for alignment.

11.8.2 Cables and Connectors

Cables should be selected using the above criteria. However it should be noted that LMR400 cable is a lot more difficult to handle and route than LMR100 cable.

Important! When using connectorized antennas, the connector can be a point of failure over time due to moisture. Accepted industry practices should be used to wrap the connector to prevent water ingress.

The male and female N-type connectors form a gas tight seal with each other, but the point where the cable enters each connector can be a point for water ingress, with eventual corrosion and failure of the connection. Wrapping and sealing is critical to long-term reliability of the connection.

One option for a weather-tight wrap around the N-type connector is Coax-Seal, made by Universal Electronics, http://www.coaxseal.com. Sealing material may also be provided with some antennas.

Start the wrap on the cable 0.5 to 2 inches inches (about 1.5 to 5 cm) from the connection and finish on the cable 0.5 to 2 inches (about 1.5 to 5 cm) above the connection. Once done wrapping, squeeze the wrap with your hand or fingers to compress and remove any trapped air. For abrasion resistance and appearances, premium vinyl electrical tape can be used over the wrap.

The connectors required at the connectorized 45 Mbps Backhaul end of the antenna cables are N-Type Male.

The connectors required at the antenna end of the antenna cables is dependant on the antenna type chosen.

11.8.3 Tools

The tools required for mounting a connectorized 45 Mbps Backhaul unit are the same as those required for a 45 Mbps Backhaul with integrated antenna detailed in section 5.3 “Tools Required”. The tools required for mounting the antennas are specific to the antenna chosen. The installer should refer to the antenna manufacturer’s instructions.

11.8.4 Miscellaneous supplies

The following miscellaneous supplies will be required:

- Cable ties, cable cleats – for securing cables
- Weather-tight wrap – to weatherproof the RF connectors
- Premium vinyl electrical tape – for additional protection of the RF connectors and securing cables

11.8.5 Mounting

11.8.5.1 Connectorized 45 Mbps Backhaul unit

A connectorized 45 Mbps Backhaul unit is supplied with the same bracket as supplied with a integrated antenna 45 Mbps Backhaul. Details on the use of this bracket can be found in section 1.3.6 “Mounting Brackets”. The connectorized 45 Mbps Backhaul unit should be mounted in a position that gives it maximum protection from the elements but still allows easy access for making off the various connections and applying the recommended weatherproofing.

When using dual polar antennas the 45 Mbps Backhaul unit should be mounted in such a position as to minimize the cable length keeping losses to a minimum (taking into account the minimum cable lengths required by the FCC regulations, see section 11.7 ”Antennas for USA / Canada”).

When using separate antennas the 45 Mbps Backhaul unit should be mounted in such a position as to minimize both cable runs between the 45 Mbps Backhaul unit and the antennas. It is not necessary to mount the 45 Mbps Backhaul unit at the mid point between the antennas.

11.8.5.2 Antennas

The Antennas should be mounted according to the manufacturers instructions. Actual antenna position will depend on the available mounting positions and link requirements. It may be necessary to mount the antennas 20m apart or at a certain distance from the ground to get the desired results.

11.8.6 Alignment Process

When aligning antennas deployed with a connectorized 45 Mbps Backhaul it may not be possible to hear the alignment tone emanating from the ODU. In this case it may be necessary for a second installer to assist in the operation. Alternately it may be possible to extend the tube on the supplied stethoscope to give a longer reach.

Tip Fine antenna alignment can sometimes be achieved by tightening and loosening the bolts on either side of the antenna mounting bracket, rather than trying to turn the whole bracket on the mounting pole.

11.8.6.1 Dual Polar Antennas

The process for aligning a dual polar antenna is the same as aligning a 45 Mbps Backhaul-I unit with an integrated antenna. This procedure is detailed in section 5.7.9 ”Aligning the ODUs”.

11.8.6.2 Separate Antennas

When using separate antennas to achieve special diversity it is recommended that one be mounted with Horizontal polarization and the other with Vertical polarization.

The following steps should be followed:

Step 1: Mount the Antennas

Step 2: Mount the 45 Mbps Backhaul unit

Step 3: Route and make off the ends of the Antenna cables

Step 4: Connect the antenna cables at the antennas

Step 5: Connect one of the antenna cables at the 45 Mbps Backhaul unit

Step 6: Connect the 45 Mbps Backhaul ODU to PIDU cable and configure the unit as described in section 5.7 ”Connecting Up”.

Step 7: Align the connected antenna using the tones as described in section 5.7.9 “Aligning the ODUs”.

Step 8: Connect the other antenna to the 45 Mbps Backhaul unit.

Step 9: Disconnect the cable to the already aligned antenna.

Step 10: Align the second antenna using the tones as described in section 5.7.9 “Aligning the ODUs”.

Step 11: Re-connect the second antenna to the 45 Mbps Backhaul (Note: you will notice the tone pitch increase as you re-connect the second antenna due to the additional received signal).

Step 12: Use the relevant status web pages to check that you are getting the results you expect from your link planning.

Step 13: Complete the installation as detailed below.

11.8.7 Completing the Installation

The installation should be completed by checking all mounting nuts bolts and screws, securing all cables and weatherproofing the installation.

Important! Final tightening of the antenna mountings may cause the antenna alignment to be altered due to distortion in the mounting bracket caused by tightening. It is recommended that the installation tone be left turned on (armed) during this process so that any movement can be noticed and counter acted by tightening the other side of the bracket.

11.8.7.1 Antenna Cable Fixing

Cables should be secured in place using cable ties, cleats or premium vinyl electrical tape. Care should be taken to ensure that no undue strain is placed on the connectors on both the 45 Mbps Backhaul unit and the Antennas and also to ensure that the cables do not flap in the wind. Cables flapping in the wind are prone to damage and induce unwanted vibrations in the mast to which the units are attached.

11.8.7.2 Antenna Connection Weatherproofing

Where a cable connects to an antenna or unit from above, a drip loop should be left to ensure that water is not constantly channeled towards the connector.

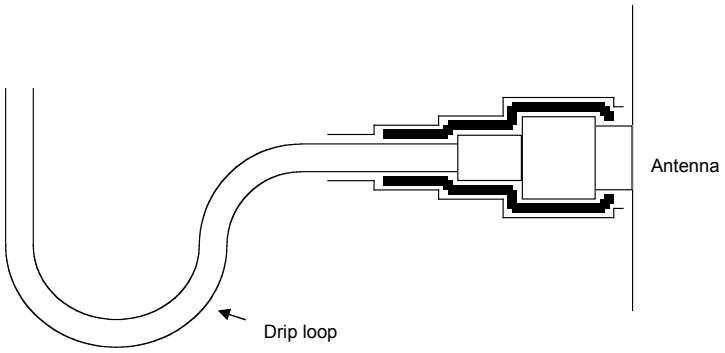


Figure 54 - Forming a Drip Loop

All joints should be weatherproofed using weather-tight wrap. It is recommended that a layer of premium vinyl electrical tape be placed over the weather-tight wrap to protect the joint while the weather-tight wrap cures and give additional protection. Figure 55 shows this diagrammatically for the 45 Mbps Backhaul unit end of the antenna cables. If the antenna's manufacturer has not supplied guidance on this matter the same technique should be employed at the antenna end of the antenna cables.

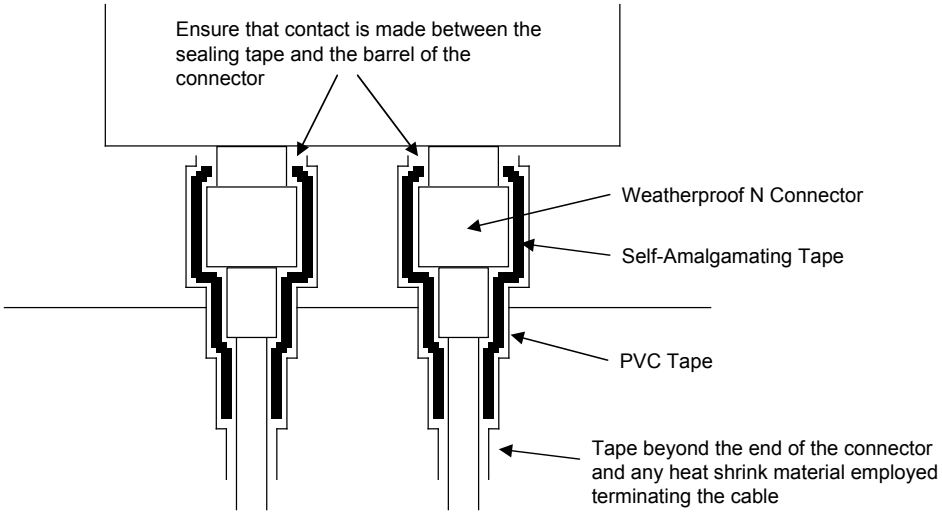

Ensure that contact is made between the sealing tape and the barrel of the connector
Weatherproof N Connector
Self-Amalgamating Tape
PVC Tape
Tape beyond the end of the connector and any heat shrink material employed terminating the cable

Figure 55 - Weatherproofing the Antenna Connections

12 FAQs

Can I source and use my own PoE adaptor with the 45 Mbps Backhaul? No. The 45 Mbps Backhaul uses a non-standard PoE configuration. Failure to use the Motorola supplied Power Indoor Unit could result in equipment damage and will invalidate the safety certification and may cause a safety hazard.

Why has Motorola launched the 45 Mbps Backhaul? The 45 Mbps Backhaul is the first product in this band to feature Multi-beam Space Time Coding. The 45 Mbps Backhaul allows wireless connections of up to 130km (81 miles) in near Line-of-Sight conditions and up to 10km (6 miles) in deep non-Line-of-Sight conditions.

What is Multi-beam Space-Time-Coding? The 45 Mbps Backhaul radiates multiple beams from the antenna - the effect of which is to significantly protect against fading and to radically increase the probability that the receiver will decode a usable signal. When the effects of Space-Time-Coding are combined with those of OFDM techniques and a best in class link budget, there is a significant improvement to the probability of a robust connection over a non-Line-of-Sight path.

What do you mean by “non-Line-of-Sight”? A wireless connection between 2 points without optical Line-of-Sight. i.e. with obstructions in between the antennas but the transmitted signal is still able to reach the receiver and produce a good quality link.

What else is special about the 45 Mbps Backhaul? There are many special features built-in to the hardware of the 45 Mbps Backhaul. The product offers the highest system gain in its class through high sensitivity antennae for improved signal recovery. It also features a Software Defined Radio system that operates on ultra fast digital signal processors but is controlled by firmware giving the ability to download new firmware when enhancements become available. The 45 Mbps Backhaul has a built-in web server for advanced management capabilities including detailed radio signal diagnosis.

In which frequency band does the 45 Mbps Backhaul operate? The Motorola 45 Mbps Backhaul operates in the unlicensed ISM band at 5.725 - 5.850GHz. This means no license is required to operate the 45 Mbps Backhaul.

Why does the 45 Mbps Backhaul operate in the 5.8GHz ISM band? The 5.8GHz band offers the dual benefits of high data throughput and good radio propagation characteristics. The wide band of spectrum available is subdivided into several channels such that multiple systems can operate in the vicinity without causing interference to one another.

Is the 45 Mbps Backhaul an 802.11a device? No, although similar, the 45 Mbps Backhaul uses different encoding and radio transmission systems than 802.11a. In areas where 802.11a systems are operating, the 45 Mbps Backhaul will detect the 802.11a radio signals and choose a clean channel away from any interference.

How much power does the 45 Mbps Backhaul transmit? At all times the 45 Mbps Backhaul operates within country / region specific regulations for radio power emissions. In addition, the 45 Mbps Backhaul uses a technique known as Transmit Power Control (TPC) to ensure that it only transmits sufficient radio power such that the other antenna can receive a high quality signal.

How does the 45 Mbps Backhaul avoid interference from other devices nearby? At initialization, the 45 Mbps Backhaul monitors the available frequency channels to find a channel that is clean from interference. In operation 45 Mbps Backhaul continuously monitors the spectrum to ensure it is operating on the cleanest channel.

How does the 45 Mbps Backhaul integrate into my data network? The 45 Mbps Backhaul acts as a transparent bridge between two segments of your network. In this sense, it can be treated like a virtual wired connection between the two buildings. The 45 Mbps Backhaul forwards 802.3 Ethernet packets destined for the other part of the network and filters packets it does not need to forward. The system is transparent to higher-level management systems such as VLANs and Spanning Tree.

How does the 45 Mbps Backhaul provide security for data traffic? The 45 Mbps Backhaul has a range of security features. At installation time each link must be programmed with the serial ID of its partner. The two ends of the link will only communicate with one another, eliminating any chance of "man in the middle"

attacks. Over the air security is achieved through a proprietary scrambling mechanism that cannot be disabled, spoofed or snooped by commercial tools. If further security is required the user is now able to optionally augment the existing high security by encoding the air interface using AES.

How is the Advanced Encryption Standard (AES) enabled? The AES facility is enabled by the user obtaining a license key from Motorola. Entering the key will turn on the AES option from which the user will be able to turn on AES. The default setting for AES is off.

How do I manage the 45 Mbps Backhaul? The 45 Mbps Backhaul has a built-in web server. At installation, the unit is configured with an IP address so that the web server can then be accessed from any browser equipped terminal. For security, access can be password protected, meaning only the network administrator can access the web based management tools. SNMP V1/V2 is also available and the unit can be configured to send traps or email notifications via SMTP.

Can I use Apple Macintosh OS X to control and monitor my 45 Mbps Backhaul? Yes, but there are some restrictions. Mozilla 1.6 is recommended. There are some issues with Internet Explorer 5.2(IE) and Safari, which could mislead the user.

How will my investment be protected as new features are developed? Future enhancements can be downloaded to the unit, meaning advances in technology or changes in regulations can quickly be applied to the system without any further hardware investment.

13 Glossary

AES	Advanced Encryption Standard	NLOS	non-Line-of-Sight
ARP	Address Resolution Protocol	ODU	Outdoor Unit
ARQ	Automatic Repeat reQuest	OFDM	Orthogonal Frequency Division
BPSK	Binary Phase Shift Keying		Multiplex
DC	Direct Current	PC	IBM Compatible Personal Computer
DFS	Dynamic Frequency Selection	PIDU	Power Indoor Unit
ETSI	European Telecommunications	PING	Packet INternet Groper
	Standards Institute	POE	Power over Ethernet
FAQ	Frequently Asked Question	PSU	Power Supply Unit
GPS	Global Positioning System	PTP	Point-to-Point
HTTP	Hypertext Transfer Protocol	QAM	Quadrature Amplitude Modulation
ID	Identity	RAM	Random Access Memory
IEEE	Institute of Electrical and Electronic Engineers	STC	Space Time Coding
IP	Internet Protocol	STP	Shielded Twisted Pair
IQ	In phase / Quadrature	TCP	Transmission Control Protocol
ISM	Industrial Scientific and Medical	TPC	Transmit Power Control
ITU	International Telecommunications Union	URL	Universal Resource Location
LAN	Local Area Network	USA	United States of America
MAC	Medium Access Control Layer	UTP	Unshielded Twisted Pair
MDI	Medium Dependent Interface	UV	Ultraviolet
MDIX	Medium Dependent Interface Crossover	VLAN	Virtual Local Area Network

14 Index

About This Guide 6
Aligning the ODUs 28
Antenna Gain 97
ARQ Is Not Configured 31
ARQ Retransmitted Rx Packets 42
ARQ State 39, 46
Auto logout Timer 74
Available Channel 35
Barring Channels 59
Cable Loss 97
Cables and Connectors 10
Change System Administration Password 71
Channel Spectrum Graphics 59
Code Word Error Ratio 42
Compliance 1, 84, 85
Configuration and Management 11
Configuring The Wireless Units 43
Confirm Configuration 49
Connecting The ODU 24
Connecting The PIDU 26
Connecting Up 23
Contact Information 7
Detailed Installation 88
DFS Configuration 58
DFS Master / Slave Relationship 56
DFS Measurements 55
DFS Online Help 62
Disable Front Page Animated GIF 74
Disable Front Page Login 74
Disable HTTP NO-CACHE META data 74
Disarm 50
Distance 16
Distance Units 74
Elapsed Time Indicator 30, 33
Electrical Requirements 16
Encryption Is Not Configured On Both Units 31
Environmental Specification 85
Ethernet Auto Mdix 39
Ethernet Compression 39
Ethernet Configuration 39
Ethernet Duplex 33
Ethernet Link Status 31, 33
Ethernet Runt Rx Packets 42
Ethernet Speed 33
FAQs 106
Fault Finding 76
Fitting A Surge Arrestor 26
Frequency Planning 16
Full Duplex 33
Gateway IP Address 34, 39

General Considerations 16
Getting Started 6
Glossary 108
Grounding The Installation 26
Half Duplex 34
Hardware Version 33
Historic DFS Metrics 61
Home Page 30
Install Arm State 31
Install Pages 43
Install Status 31
Installation 21
Installation Procedure 21
Installation Support 21
Internet Protocol Configuration 44
IP Address 34, 39
L2 Source MAC Address Conflicts 42
Lan Rx Packets 42
Lan Tx Packets 42
Legal Disclaimer 22
Lightning Protection 16, 88
Link Location 32, 38
Link Loss 34
Link Name 30, 32, 38
Link Symmetry 38, 46
Local Packet Filtering 39
MAC Address 34
Master and Slave have Incompatible Region Codes 31
Master Slave Mode 46
Max Transmit Power 47
Maximum Transmit Power 39
Measurement Analysis 55
Mounting Brackets 11
Mounting the ODUs 22
Mounting The PIDU 27
Networking Information 16
ODU Site Selection 17
ODU to PIDU Connection 87
45 Mbps Backhaul C 94
Outdoor Unit (ODU) 8
Overview 88
Packets From Internal Stack 42
Packets To Internal Stack 42
Path Loss Considerations 18
PHY Code Word Error Counter 42
PIDU Mains Power 10
PIDU Site Selection 17
Pole Mounting 22
Power Indoor Unit (PIDU) 8
Powering Up 27
Preparation 21
Preparing The RJ45 23
Product Architecture 15

Product Description 7
Radio Certifications 85
Range 36
Ranging Mode 47
Receive Data Rate 35, 42
Receive Modulation Mode 35
Receive Power 34
Refresh Page Period 36, 58, 59
Region Code 33
Remote Management Page 66
Remote Transmit Maximum Power 34
Repair and Service 7
Reset System Counters 42
Reset System Histograms 42
Routing the Cable 26
Safety 6
Signal Strength Ratio 42
Site Planning 17
Site Selection Criteria 17
SMTP (Simple Mail Transport Protocol) .. 69
SMTP Destination Email Address 69
SMTP Email Alert 69
SMTP IP Address 69
SMTP Port Number 69
SMTP Source Email Address 69
SNMP (Simple Network Management Protocol) 67
SNMP Community String 68
SNMP Configuration 68
SNMP MIBs 67
SNMP State 68, 69
SNMP Trap IP Address 69
SNMP Trap Port Number 69
SNTP (Simple Network Time Protocol) ... 70
SNTP IP Address 70
SNTP Poll Interval 70
SNTP Port Number 70
SNTP State 70
SNTP Time Zone 70
Software Upgrade 52
Software Version 33
Specifications 80
Spectrum Management (Non UK) 55
Spectrum Management Channel Warning 32
Spectrum Management Control 47, 97
Statistics Page 41
Statistics Page Refresh Period 42
Subnet Mask 34, 39
Surge Arrestor 11
System Administration Pages 37
System Clock 31
System Configuration Page 37
System Connections 87
System Specifications 80

Systems Status Page 32
Target MAC Address 46
Target Receive Modulation Mode 34, 38
Tools Required 21
Transmit Data Rate 35, 42
Transmit Modulation Mode 35
Transmit Power 34
Vector Error 34
Wall Mounting 22
Wan Bad Rx Packets 42
Wan Dropped Tx Packets 41
Wan Good Rx Packets 41
Wan Good Tx Packets 41
Web Page Reference 30
Welcome 6
Who Should Use This Guide 6
Wind Loading 92
Wireless Channels 55
Wireless Configuration 46
Wireless Link Availability 42, 55, 56
Wireless Link Status 30, 34